EMR

INSTRUCTION MANUAL

SUBCARRIER DISCRIMINATOR
MODELS 67D AND 67F

Revision A

ELECTRO-MECHANICAL RESEARCH, INC. SARASOTA, FLORIDA

INSTRUCTION MANUAL

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MODELS 67D AND 67F

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Electro-Mechanical Research Inc.
Sarasota, Florida
March 1965

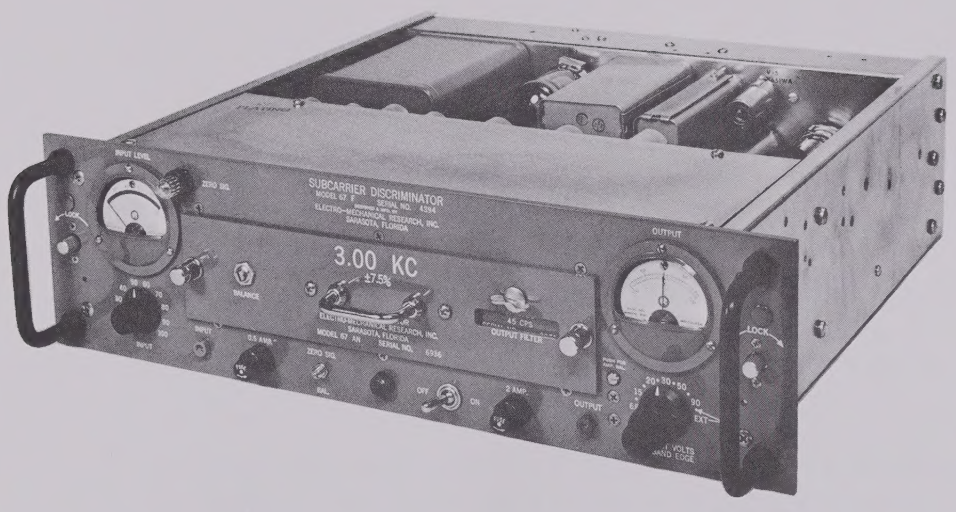
ERRATA SHEET

EMR MODEL 67D AND 67F (Sheet 1 of 2)
SUBCARRIER DISCRIMINATOR

All changes to Section VI, Replaceable Parts.

Page		Nature of Errata
1	Delete	R1, 100 ohms, 25 W
	Change	R30 from 5.5 K to 2.5 K, Dale RH-25
	Change	R31 from 5.5 K to 3.5 K, Sage, SS10W
	Add	R33, 50 ohms, Sage, 55W, 3%
	Add	R34, 330 K
	Add	R35, 330 K
	Add	R36, 330 K
	Add	R37, 330 K
	Add	R38, 330 K
	Add	R39, 330 K
	Add	R40, 330 K
	Add	R41, 330 K
3	Change	R316 from 75 K to 56 K, Allen Bradley, 2 W, 10%
	Change	R317 from 820 K to 390 K
4	Change	R424 from 1.8 K to 100 ohms
	Change	R429 from 3.3 K to 2.2 K
5	Change	R437 from 220 K to 330 K
	Change	R469 from 390 K to 220 K, Allen Bradley, EB, 5%
	Change	R470 from 6 K to 3.3 K, Allen Bradley, EB, 5%
	Add	R477, 10 K, Allen Bradley, EB
	Add	R478, 220 K, Allen Bradley, EB
	Add	R479, 270 K, Allen Bradley, EB
	Add	R480, 22 K, Allen Bradley, EB
	Add	R481, 330 K, Allen Bradley, EB
	Add	D1, 1N1697
	Add	D2, 1N1697
	Add	D3, 1N1697
	Add	D4, 1N1697
	Add	D5, 1N1697
	Add	D6, 1N1697
	Add	D7, 1N1697
	Add	D8, 1N1697
	Change	D402 from 1N1998A to 1/4 M100Z5, Motorola Zener, 100 V
	Change	D403 from 9GA20 to 1N1697, G.E., Silicon Rectifier
	Add	D404, 1N626
	Add	D405, 1N626
	Add	D406, 1N1697, G.E., Silicon Rectifier

Page		Nature of Errata
6	Add	C18, 10 μfd., Sprague, CP70B1FF160V, 600 V
7	Add	C308, 560 μμfd., 300 V, 10%
	Change	C413 from 0.0039 Mfd. to 0.015 μfd
	Add	C414, 82 μμfd.
	Change	C416 from 0.001 Mfd to 300 μμfd.
8	Delete	V1, Full Wave Rectifier
	Delete	V2, Full Wave Rectifier
12	Change	R1441 from 470 K to 425 K



PRECISION SUBCARRIER DISCRIMINATOR
MODEL 67

CAUTION

MODEL 67F DISCRIMINATORS MUST NOT BE OPERATED UNLESS BOTH 115 V SUPPLIES ARE ENERGIZED. (PINS 1 AND 2; PINS 3 AND 4).

FAILURE TO OBSERVE THIS PRECAUTION WILL RESULT IN UNREGULATED B SUPPLY VOLTAGES WHICH EXCEED COMPONENT BREAKDOWN LIMITS CAUSING DAMAGE TO POWER SUPPLY PARTS.

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SECTION 1
DESCRIPTION OF UNIT

1.1 GENERAL

The EMR Model 67 Subcarrier Discriminator is a precision instrument designed for use in FM telemetry and data-recording systems. This versatile unit contains its band-pass input filter, tuning unit, and low-pass output filter in a single front-panel plug-in unit. (An additional plug-in unit changes the cut-off frequency of the low-pass output filter.)

The discriminator is insensitive to spurious signals as large as 90% of the desired subcarrier signal. In addition to the resulting in-channel improvements, this characteristic greatly reduces the attenuation requirements of the band-pass input filter.

Straight-line linearity and minimal zero drift are features of the Model 67. True base-line limiting of the subcarrier practically eliminates amplitude modulation and reduces to a minimum the effect of step-function changes normally encountered in magnetic-tape dropouts.

The Model 67 Subcarrier Discriminator consists of a basic chassis into which a compatible EMR channel selector can be inserted through the front panel. Each channel selector contains a band-pass input filter, a tuning unit, and an interchangeable low-pass output filter. Time correlation between data channels can be provided by special output filters that are available on special order.

The basic discriminator is operable over the center-frequency range of 125 cps to 123 kc, including all IRIG channels delineated in Table I-1. The specific plug-in channel selector (with output filter) utilized establishes the center-frequency, deviation, intelligence bandwidth, and phase for each channel. Any Model 67 can be used as the reference discriminator in an EMR tape-speed-compensation system if the proper channel selector and reference low-pass output filter are employed.

The discriminator is available either with an integral electronically regulated low-voltage supply (Model 67D) or with an unregulated power transformer (Model 67F). Provision is made on the Model 67F for the input of 25 watts of regulated power (±1%) for application to critical heaters.

The Model 67 consists of two main structural sections. The rear section contains the power supply and the chassis-to-rack connector; all other components are contained in the front section. The center region between these sections is open, facilitating air circulation about the tubes and other heat-producing components. When several units of similar chassis configuration are mounted in a rack, the open centers form a duct through which air can be forced by a blower.

The superior performance of this discriminator has established a standard in the telemetry field.

1.2 CHARACTERISTICS

The basic discriminator unit is operable over the frequency ranges and deviations stated. The channel selector, which includes the band-pass input filter, the tuning unit, and the output filter, establishes subcarrier center frequency, deviation, and intelligence bandwidth.

Subcarrier Frequencies: IRIG center frequencies are standard. See Table I-1. Other center frequencies between 125 cps and 123 kc are available on special order.

Subcarrier Frequency Deviation: ±7.5% and ±15%, as specified by the IRIG, are standard. Deviations of ±5% to ±50% are available on special order. Minimum and maximum band-edge frequenceis are 115 cps and 133 kc.

Data Frequencies: IRIG data frequencies are standard. See Table I-1. Output filters having cutoff frequencies between 0.5 and 21,000 cps are available on special order.

Input Impedance: 500,000-ohm resistance shunted by the reactance of approximately 30 μμf.

Subcarrier Signal Range: 10 millivolts minimum. The input potentiometer can be used to attenuate large input signals. The dynamic input range is 30 db.

Amplitude-Modulation Rejection: With a deviation ratio of 5, a 6-db step of subcarrier amplitude causes a peak transient of less than 1% of bandwidth.

Rejection of Unwanted Signals: Full-scale modulation on an adjacent ±7.5%-deviation IRIG channel is attenuated 50 db in the extreme case where the interfering signal has an amplitude 16 db greater than the desired signal at the input to the discriminator.

Tape-Speed-Compensation System: The EMR tape-speed-compensation system used with the Model 67 Discriminator has a guaranteed wow-and-flutter improvement ratio of 35 db for tape-speed variations as large as ±5%.

Linearity: The best-straight-line linearity is ±0.1% of bandwidth.

Output Noise: The rms value is less than 0.1% of the full-bandwidth voltage.

Output-Zero Stability: ±0.5% of full bandwidth in a 15-hour period after a 15-minute warm-up.

TABLE I-1
IRIG STANDARD CHANNELS

IRIG Channel Number	Channel Center Freq. (kc)	Deviation (%)	Output Cutoff Freq. (cps)
1	0.40	±7.5	6
2	0.56	±7.5	8.4
3	0.73	±7.5	11
4	0.96	±7.5	14
5	1.30	±7.5	20
6	1.70	±7.5	25
7	2.30	±7.5	35
8	3.00	±7.5	45
9	3.90	±7.5	59
10	5.40	±7.5	81
11	7.35	±7.5	110
12	10.5	±7.5	160
13	14.5	±7.5	220
14	22.0	±7.5	330
15	30.0	±7.5	450
16	40.0	±7.5	600
17	52.5	±7.5	790
18	70.0	±7.5	1050
A	22.0	±15	660
B	30.0	±15	900
C	40.0	±15	1200
D	52.5	±15	1600
E	70.0	±15	2100

Deviation-Sensitivity Stability: ±0.25% in a 15-hour period after a 15-minute warm-up.

Output Voltage and Current: The output voltage is single ended and referenced to ground. The deviation sensitivity is negative. The band-edge output voltage is continuously variable from 6.6 to 90 volts dc with a maximum current of 25 ma.

Output Impedance: Less than 10 ohms.

Harmonic Distortion: For deviation ratios of 5 or greater, the harmonic distortion for full-bandwidth modulation does not exceed 1% for any modulation frequency up to the cutoff frequency of the channel.

Low-Pass Output Filter Response: Eight types of output filters are available:

1. SF-67DL-(freq.): A 36-db/octave constant-amplitude filter. The amplitude of the response is flat within ±0.5 db up to the cutoff frequency for cutoff frequencies equal to or less than 2100 cps. For cutoff frequencies greater than 2100 cps the response may be down as much as 1 db at the cutoff frequency.

2. GF-67DL-(freq.): A 36-db/octave constant-delay filter used primarily in pulse-modulation or time-correlation systems. The amplitude of the response is down 2.4 ±0.3 db at the cutoff frequency for cutoff frequencies equal to or less than 2100 cps. For cutoff frequencies greater than 2100 cps the response may be down as much as 3.5 db at the cutoff frequency.

3. SF-67DLL-(freq.): A 48-db/octave constant-amplitude filter. The response is constant within ±0.3 db up to the cutoff frequency for cutoff frequencies equal to or less than 2100 cps. For cutoff frequencies greater than 2100 cps, the response may be down as much as 1 db at the cutoff frequency.

4. GF-67DLL-(freq.): A 48-db/octave constant-delay filter used primarily in pulse-modulation or time-correlation systems. The amplitude of the response is down 2.4 ±0.3 db at the cutoff frequency for cutoff frequencies equal to or less than 2100 cps. For cutoff frequencies greater than 2100 cps, the response may be down as much as 3 db at the cutoff frequency.

5. "O" (offset) filter: All of the previously described filters are available in an "O" version which is designated by "-O" after the cutoff frequency. This filter is used primarily for high-frequency channels with large deviations; it reduces nonlinearity caused by the rise time of the FM detector circuit. Filter response is not affected by the O-type circuitry. Consult EMR for further information.

6. SF-67DI-(freq.) or GF-67DI-(freq.): 24-db/octave filters that provide positive deviation sensitivity. Consult EMR for further information.

7. "P" (phase-adjustable) filter: This filter is designated by "-P" after the cutoff frequency and is used primarily in time-correlation systems. Consult EMR for further information.

8. RF-67T or RF-67D-(system): These filters are used in an EMR tape-speed-compensation system to provide filtering for the reference signal. For ordering information, refer to the catalog literature relative to EMR Models 96 and 161.

Output Voltage Limit: The output voltage is limited to 140% of the band-edge voltage.

Zero-Signal Protection: A front-panel control is provided for returning the discriminator output to any range within design deviation in the event of loss of subcarrier input. A zero-signal light is provided to indicate loss of usable input-signal level.

Automatic Calibration: Provision is made for introduction of an external zero-set and for external control of the output amplifier gain, either manually or automatically, with an EMR ground-station calibration system.

Power Requirements:

Model 67D--180 watts at 105 to 125 volts unregulated, 60 cps. The output-zero stability is approximately 1% of bandwidth per 1-cps change in power-line frequency.

Model 67F--155 watts at 105 to 125 volts unregulated, 55 to 70 cps, and 25 watts at 115 volts ±1%, 55 to 70 cps.

Tube Complement: 1 type 6080, 3 type 6AW8A, 1 type 5651WA, 2 type 12AT7, 2 type 12AY7, 5 type 6AU6, 1 type 6AL5, 1 type 5964, 1 type 6201, 1 type 6136, 1 type 6U8, 1 type 6197, 1 type 6L6GB.

Panel Size: 6-1/4 in. by 19 in.

Chassis Size: 16-3/8 in. wide by 16-1/8 in. deep.

Over-all Depth: 16-3/8 in. maximum.

Weight: Approximately 50 pounds, complete with channel selector and output filter plug-ins.

Shipping Weight:

Basic Chassis--55 pounds.
Channel Selector--6 pounds.
Low-Pass Output Filter--1 pound.
Complete Discriminator--59 pounds.

Panel Finish: EMR light umber gray enamel with white lettering.

Mounting: Can be equipped with or without pullout slides, which can be specified to be tilt or nontilt. Front-panel lock fasteners secure the unit in the rack.

Controls (all on front panel):

"Input" potentiometer
"Zero Signal Balance" potentiometer
"Output Volts at Band Edge" switch (fine adjustment within selected range made possible by potentiometer-control switch shaft)
"Amplifier Balance" pushbutton switch and potentiometer
"On-Off" switch

Indicators:

Pilot bulb indicates when power is on.
"Zero Signal" light

Meters: "Input Level" and "Output"

Test Jacks: "Input" and "Output"

Connector: Cannon type DPD-D32C2-34P-1L. Mates with Cannon type DPD-D32C2-33S-1L (supplied).

SECTION II
INSTALLATION AND OPERATION

2.1 UNPACKING

The Model 67 Subcarrier Discriminator is shipped with all components plugged in.

After unpacking, examine the unit thoroughly to determine whether any damage occurred in shipment. Report any damage at once, in accordance with instructions on the reverse side of the EMR Purchase Order Authorization.

2.2 MOUNTING (IN 19-INCH-WIDE SPACE)

When slides are not used, the Model 67 can be mounted in the rack by means of angle brackets that support the unit on its side brackets.

When pullout, nonturnover slides and slide-mount hardware have been specified, a spacer bar having three screw holes is supplied on each side of the Model 67. After the slides have been installed in the rack, pull forward the innermost subassembly of the slides until the full-extension stop engages. Depress the stop button and withdraw this subassembly completely. Mount the subassembly to the spacer bar on the discriminator by means of the three No. 10-32 screws provided. Repeat this procedure for the other side of the discriminator, then insert the unit into the rack--again depressing the stop buttons.

When pullout, turnover slides and slide-mount hardware have been specified, a spacer bar having six screw holes and a helical insert is supplied on each side of the Model 67. After the slides have been installed in the rack, pull forward the innermost subassembly of the slides until the full-extension stop engages. Depress the stop button and withdraw completely this subassembly. Mount the subassembly to the spacer bar on the discriminator by means of the six Phillips screws provided. Use the indexing pin to lock the tilt mechanism in the 0° (horizontal) position. Repeat this procedure for the other side of the discriminator, then insert the unit into the rack--again depressing the stop buttons. The tilt mechanism provides seven positions: 0°, $\pm 45^{\circ}$, $\pm 90^{\circ}$, and $\pm 150^{\circ}$.

Secure the unit in the rack by means of the two twistlock fasteners located beside the handles.

2.3 COOLING

The physical construction of the Model 67 Discriminator is similar to that of most other EMR rack-mounting equipment. All power-consuming components are extended into a chimney area to allow for forced-air cooling from a blower mounted behind the power panel at the bottom of the rack. This design aids in obtaining maximum life of components and maximum dependability with a minimum of maintenance. Because of this EMR construction practice, most EMR rack-mounting

equipment can be placed above or below the Model 67 without obstructing the chimney formed when a number of units are stacked in a rack.

CAUTION

If the Model 67 is operated horizontally on a bench out of the rack, elevate it approximately two inches above the surface of the bench to allow for free-air convection cooling.

2.4 ELECTRICAL CONNECTIONS

External connections to the discriminator are made through the Cannon plug located on the rear plate of the chassis. A Cannon DPD-D32C2-33S-1L receptacle is supplied for connection to this plug.

Refer to Table II-1 for proper connections to this plug.

2.5 INPUT LEVEL CONTROL AND MONITOR

The INPUT control (R-120) located on the front panel permits attenuation of large input signals to an optimum operating range for the band-pass input filter. This range is indicated by the green area of the INPUT LEVEL meter. An input signal over 10 millivolts rms will produce proper discriminator operation, although for such low signals the INPUT LEVEL meter may register below the green area. Since signal amplitude variations might cause operation drop-outs, it is preferable not to operate in this low signal region unless the signal level is quite constant.

2.6 LOW-PASS OUTPUT AMPLIFIER

2.6.1 Front-Panel Output Control

The output voltage for full bandwidth deviation is controlled by the OUTPUT VOLTS AT BAND EDGE concentric switch and variable resistor (SW-401 and R-447) located on the front panel. The markings on either side of the detent position of the pointer indicate the output voltage range. The concentric control (R-447) varies the output voltage over the range indicated for any of the first five switch positions. With this arrangement, the output voltage for full bandwidth deviation can be continuously varied from about ±6.6 volts to ±90 volts.

NOTE: For the first five positions of SW-401 to be operative, the feedback path of the second output amplifier section must be completed through the external #1A and #1B leads by connecting Pins 24 and 25 on the Cannon connector.

The sixth switch position, labeled "EXT", provides an opportunity to replace the entire feedback output control system of SW-401 and R-447 with an external system so that remote control can be achieved.

TABLE II-1
REAR CONNECTOR PIN FUNCTIONS
MODELS 67D & 67F

Pin No.	Connector Pin Function
A1	Subcarrier Input
A2	No connection
1 & 2	Unregulated A-C Input
3 & 4	Regulated A-C Input on Model 67F (Other Models-No connection)
5*	Remote Meter + Terminal Jumper together if remote meter not used
6*	Remote Meter – Terminal Jumper together if remote meter not used
7 & 8	Low Impedance Output (Either pin)
9	Ground Connection Available
10*	Ext. gain No. 2 - See Dwg. B-01983. Jumper to Pin 8 if Ext. gain not used
11	Ground Connection Available
12	Ground Connection Available
13	Ground Connection Available
14	Ground Connection Available
15	Ground Connection Available
16	200 Volts B+ Available
17	200 Volts B– Available
18	No connection
19*	External Zero Offset - Jumper to Ground if unused
20	No connection
21	No connection
22*	Wow and Flutter Compensation Input. Jumper to Ground if unused
23	No connection
24*	Ext. gain No. 1B See Dwg. B-01983 for connection - Jumper together if Ext. gain not used
25*	Ext. gain No. 1A See Dwg. B-01983 for connection - Jumper together if Ext. gain not used
26	Ground Connection Available
27	Subcarrier Monitor (Same point as Input Jack - Front Panel)
28	Ground Connection Available
29	Ground Connection Available
30	Ground Connection Available

* For normal operation, these Jumper connections must be made.

The output impedance for all voltage ranges and frequencies is less than 10 ohms. The maximum current load should not exceed ±25 ma. No output impedance matching is required.

In all positions of SW-401 and R-447 the output meter, M-401, indicates percent deviation from band center to band edge since it is connected to the feedback point.

> NOTE: For Position 5 of SW-401 with R-447 full clockwise, somewhat more than ±90 volts for full bandwidth deviation may be obtained on some units. Since full-output specifications including linearity are not necessarily maintained beyond the ±90-volt point, R-447 should be adjusted back to this point when full deviation is to be used.

2.6.2 External Gain Control

The gain of the second section of the output amplifier may be controlled externally in two ways:

(1) With the Output Gain Control Switch (SW-401) in any of the first five positions, the gain may be varied upward by adding an additional resistor divider to ground from the external # 1A lead on Pin 25 of the Cannon connector as shown schematically in Figure II-1. The center point of this additional external divider is returned to the amplifier feedback point through the external gain # 1B lead on Pin 24 of the connector.

> NOTE: The external leads used for connecting the external divider should be low capacity shielded cable and the sum of the shield capacity to ground should be less than 700 μμf.

If a portion of this external resistor divider is made a potentiometer with the wiper returned to the feedback point, this arrangement has the advantage that a given variation in the wiper position will vary the output gain the same percentage, independent of the output gain control setting of SW-401 and R-447.

The total value of this external divider should preferably be between 10K and 20K ohms so that the lower portion of the internal divider across which the external divider appears is not shunted excessively. A condenser of about 1000 μμf should be connected from the top of the external feedback divider (External Gain #1A input) to the feedback point (External Gain # 1B).

By this method, the gain may be increased from that given by any setting of the internal controls SW-401 and R-447. The maximum setting made by means of this external control should not exceed by more than about 30% the gain achieved without the external control; otherwise, the divider will draw excessive current from the output for full bandwidth deviations, thus lowering the maximum output-current capability.

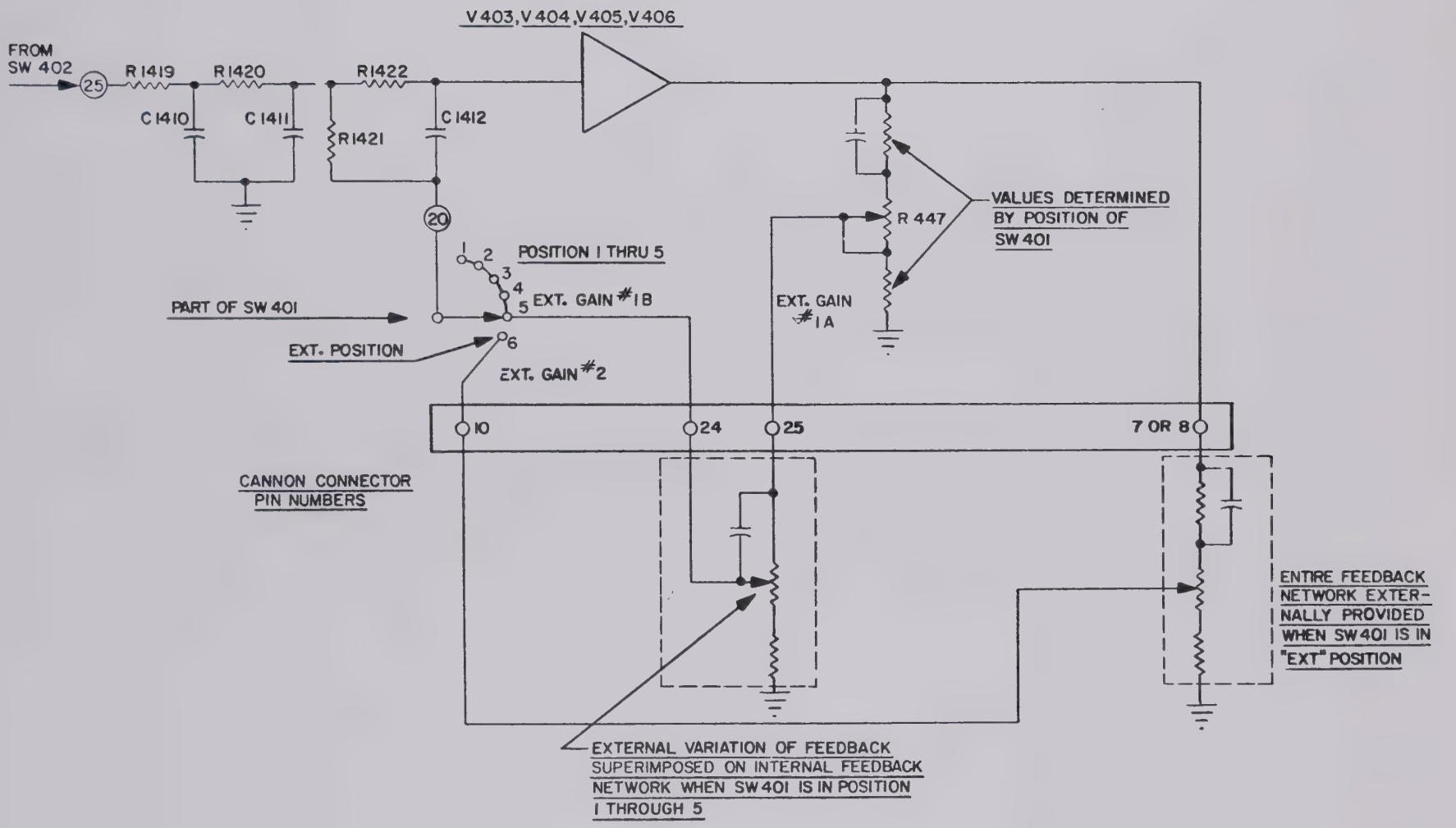


FIGURE II-1. SCHEMATIC FOR VARYING GAIN EXTERNALLY

(2) With the Output Gain Control Switch (SW-401) in the EXT position, a second method of externally varying the gain of the second section of the output amplifier may be obtained. In this position the feedback point of the second amplifier section is returned to Pin 10 of the Cannon connector via the External Gain# 2 lead as is also shown in Figure II-1. In this position the amplifier is inoperative unless feedback from the output on Pins 7 or 8 is introduced externally to Pin 10. Suitable external-feedback-divider-resistor values for specific gain ranges should approximate those used on SW-401. Capacitors across the upper divider arm of the external divider should be used with comparable values to those used on SW-401. By using this position for external gain all other positions remain for normal control with SW-401.

> NOTE: The external lead used for the feedback return to Pin 10 must be low-capacity shielded cable of less than 700-μμf total capacity to ground.

If the EXT position #6 of SW-401 is not used, it is advisable to jumper the output on Pins 7 or 8 to Pin 10 so that the output stage will not saturate if the switch is inadvertently thrown to EXT.

2.7 POWER SOURCE

The Model 67D Discriminator operates from a source of 105 to 125 volts, 60 cps regulated, single phase (180 watts at 115 volts).

The Model 67F Discriminator requires two sources of power: one is a source of 105 to 125 volts, 55 to 70 cps, single phase (155 watts at 115 volts); the other is a 25-watt source of 115 volts, regulated to within ±1% at 55 to 70 cps, single phase.

2.8 POWER SWITCH

After the discriminator has been connected to the mating receptacle in the rack, it may be turned on by means of the power switch on the front panel. The panel light indicates that power has been applied.

2.9 MAGNETIC-RECORDER/REPRODUCER TAPE-SPEED-ERROR COMPENSATION

The ground of the discriminator time-constant-control resistor R-1332 is returned through Cannon connector pin 22 at the rear of the discriminator. For normal operation without compensation, this point must be connected to ground (pin 15 or 30). When magnetic-tape-speed-error compensation is to be applied, this pin should be removed from ground and connected to the compensation-system output.

2.10 CENTERING CONTROL

The discriminator center-frequency BALANCE control is located on the front panel of the Channel Selector Unit. With a known input frequency such as the

center frequency, this control should be adjusted to provide the desired output voltage. (0 volts for the center frequency.) The output meter on the panel may be used in this adjustment; however, for greater accuracy, an external dc meter should be used. Since the balance control is a ten-turn unit, output voltage adjustments to a tolerance closer than 0.1% of full bandwidth may be achieved.

2.11 ZERO SIGNAL BALANCE CONTROL

With no input signal to the discriminator, the ZERO SIGNAL Balance control may be set so that the output returns to any particular point within the selected output range. Adjustment of this control does not affect operation when a normal input signal is present.

2.12 ZERO SIGNAL LIGHT

The zero signal lamp on the front panel glows when the input level is insufficient for discriminator operation.

Proper operation of the neon bulb can be checked by depressing the plastic cover of the indicator light.

2.13 CALIBRATION CHECK

Althought the calibration may be checked by various methods, a 3-point check should be sufficient. If the discriminator is first adjusted for zero output at the center frequency, the outputs at the two band edges should differ by less than 0.2% of full bandwidth, indicating a maximum error of 0.1% or less. It is of primary importance that the calibration frequencies be accurately determined and that the output-voltage measuring device be extremely accurate to determine this degree of calibration precision.

2.14 INPUT MONITOR

The input signal may be monitored on pin 27 of the Cannon output connector at the rear of the chassis or at the INPUT monitor jack located on the front panel. The signal level at this point will be of the order of 1 volt RMS for an input level of approximately "50" on the INPUT LEVEL meter. The level will, of course, depend on the input signal strength and the setting of the input control. The impedance at the monitoring point is approximately 800 ohms.

In addition to being displayed on the INPUT LEVEL located on the front panel, the input level may be monitored remotely by connecting a meter to pins 5 and 6 of the Cannon rear chassis connector. A jumper must be placed across these pins when the external meter is not used.

The INPUT monitor jack on the front panel of the discriminator does not have an associated ground connection. Ground may be obtained by clipping a ground lead anywhere on the chassis.

2.15 OPERATING SIGNAL LEVEL AND TAPE DROP OUT

Since the linear range of the input amplifier over which limiting occurs is greater than 30 db, the discriminator will often provide an output before the INPUT LEVEL meter has reached 1% of full scale. While the unit will operate satisfactorily under these conditions, it is preferable to operate above "6" on the input meter to insure limiting signals with small amplitude variations.

When the input subcarrier signal has large amplitude modulation, the input level should be adjusted by means of the input control to about 40 on the INPUT LEVEL meter. This will provide optimum amplitude rejection.

If, however, the amplitude variation of the input signal is extremely large, such as can be encountered by tape recorder-reproducer drop-outs, it might be preferable to operate with the input level meter between 75 and 85. This would make full use of the dynamic operating range of the discriminator.

2.16 OUTPUT JACK

The OUTPUT jack located on the discriminator front panel is internally connected to the output of the low-pass filter output amplifier. Since the OUTPUT Jack does not have an associated ground connection, a ground lead must be clipped to the chassis. The output voltage will be negative with respect to the chassis when a subcarrier signal higher than center frequency is applied to the discriminator.

2.17 LOW-PASS OUTPUT AMPLIFIER EXTERNAL OFFSET

The zero-output position of the low-pass output amplifier can be varied by injecting a suitable voltage on pin 19 of the rear Cannon connector. This voltage is impressed on the grid of V-401A through a 425K resistor (R-1438) contained in the low-pass output filter plug-in unit. A ±1-volt signal will vary the output approximately ±12% of bandwidth.

Any external zero offset voltage should be provided through a shielded cable from a source impedance of less than 5,000 ohms.

> NOTE: When the external zero offset is not being used pin 19 must be returned to ground.

2.18 LOW-PASS OUTPUT AMPLIFIER BALANCE ADJUSTMENT

In order that the gain of the second section of the output amplifier may be varied by SW-401 and R-447 without affecting the output zero position, the amplifier must have zero output with zero input. This adjustment is made by using a screwdriver to completely depress the PUSH FOR AMP. BAL. shaft on the front panel of the discriminator in as far as it will go and rotating the shaft until the output is exactly zero volts. Depressing the shaft causes SW-402 to short the input to this second amplifier section and engages the shaft of R-450 so that rotating the shaft adds or subtracts a voltage to or from the amplifier through R-1441. This adjustment should be made only after a 15-minute warm-up period.

SECTION III
THEORY OF OPERATION

3.1 GENERAL

The essential stages of the discriminator consist of a band-pass input filter and amplifier, a limiter, a pulse generator, a trigger circuit frequency discriminator and a low-pass output filter amplifier as shown by the block and waveform diagram, Figure III-1. In order that a large number of units may be operated in parallel on different channels, the input impedance is high (500 K ohms), and is shunted by the reactance of approximately 30 $\mu\mu$f.

The band-pass input filter consists of four stagger-tuned LC circuits located between V-101A and V-103A. Tube V-103 is a voltage amplifier which provides the required amplitude of subcarrier signal level to the limiter circuit. The limiter circuit consisting of V-201, V-202 and V-203 provides a square-wave output to the pulse-forming stage V-301, which in turn triggers the discriminator at the plate of V-302. The circuits associated with tubes V-302, V-303 and V-304 constitute the frequency discriminator. Cathode-follower V-303A serves the dual purpose of providing a low driving impedance for the RC network of the frequency discriminator as well as a low-impedance output to the low-pass output filter amplifier. The low-pass output filter amplifier V-401, V-402, V-403, V-404, V-405 and V-406 removes the subcarrier frequency from the intelligence frequency and provides a low-impedance output for the discriminator at the cathode of V-406. This output, which has a source impedance of less than 10 ohms, is designed to supply from +6.6 volts to ±90 volts at maximum current of 25 milliamperes for full-bandwidth deviation. The INPUT LEVEL meter is driven by the circuit containing diodes D-101 and D-102. Tube V-305 provides low-pass filter output amplifier clamping to any desired point when the subcarrier input to the discriminator is zero. Diodes D1 through D8 are the power-supply rectifiers, and tubes V-3, V-4, V-5 and V-6 constitute the voltage-regulator circuits which provide constant B+ and B− voltages to the discriminator circuits.

3.2 BAND-PASS INPUT FILTER AND AMPLIFIER, V-101, V-102 AND V-103

The input circuit is designed to accommodate any subcarrier input level from 10 millivolts to 10 volts. The input attenuator reduces larger amplitude signals to an optimum level. Overloading of the input circuits and band-pass filter is thereby avoided and the possibility of the inter-modulation is greatly reduced. The band-pass input filter, which consists of four tuned LC circuits that are separated by cathode followers V-101 and V-102, is adjusted for a gain of approximately 15. A typical attenuation curve of the filter, measured between the input and the plate of V-103B is shown in Figure III-2. The voltage amplifier circuit, V-103, is designed to provide a gain of approximately 20, and its output will remain linear for voltages as high as 35 volts RMS. This linearity is realized by the use of a large amount of negative feedback within the amplifier. Amplifier frequency response is flat to ±1 db from 400 cycles to 100 kc.

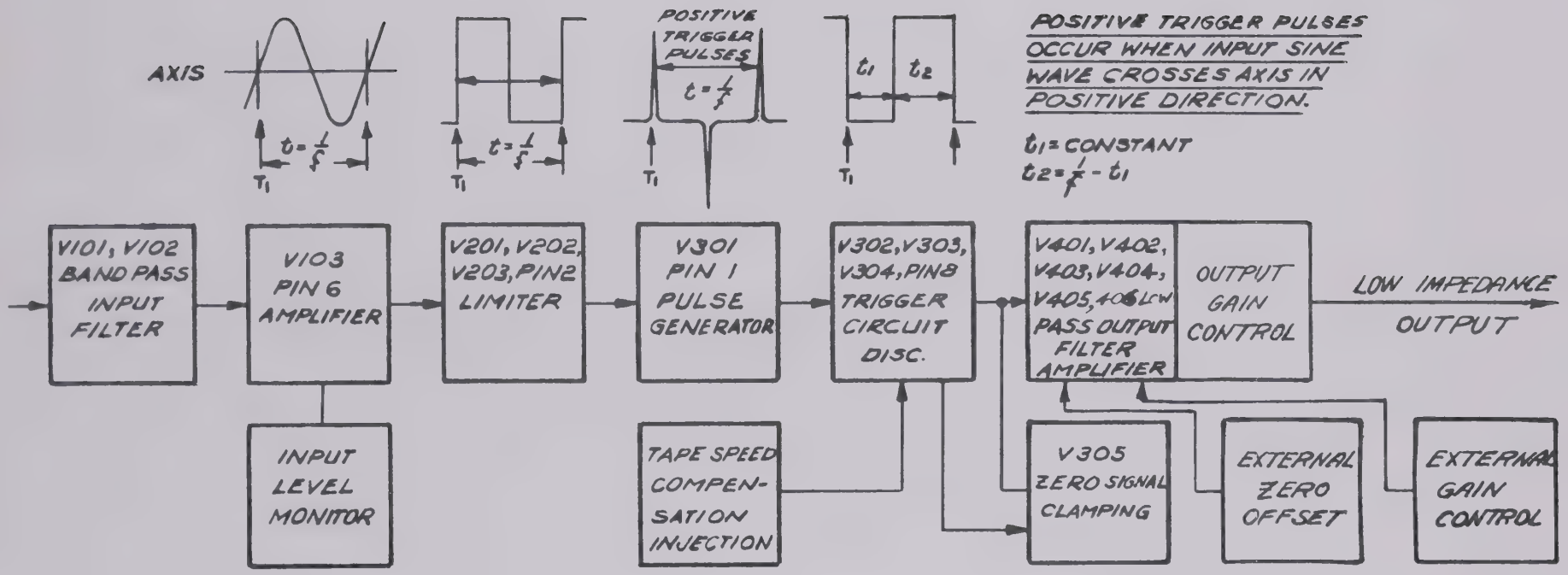

AXIS
$t = \frac{1}{f}$
T_1
POSITIVE TRIGGER PULSES
$t = \frac{1}{f}$
t_1
t_2
POSITIVE TRIGGER PULSES OCCUR WHEN INPUT SINE WAVE CROSSES AXIS IN POSITIVE DIRECTION.
t_1 = CONSTANT
$t_2 = \frac{1}{f} - t_1$
V101, V102 BAND PASS INPUT FILTER
V103 PIN 6 AMPLIFIER
V201, V202, V203, PIN2 LIMITER
V301 PIN 1 PULSE GENERATOR
V302, V303, V304, PIN8 TRIGGER CIRCUIT DISC.
V401, V402, V403, V404, V405, 406 LOW PASS OUTPUT FILTER AMPLIFIER
OUTPUT GAIN CONTROL
LOW IMPEDANCE OUTPUT
INPUT LEVEL MONITOR
TAPE SPEED COMPEN-SATION INJECTION
V305 ZERO SIGNAL CLAMPING
EXTERNAL ZERO OFFSET
EXTERNAL GAIN CONTROL

FIGURE III-1. BLOCK AND WAVEFORM DIAGRAM

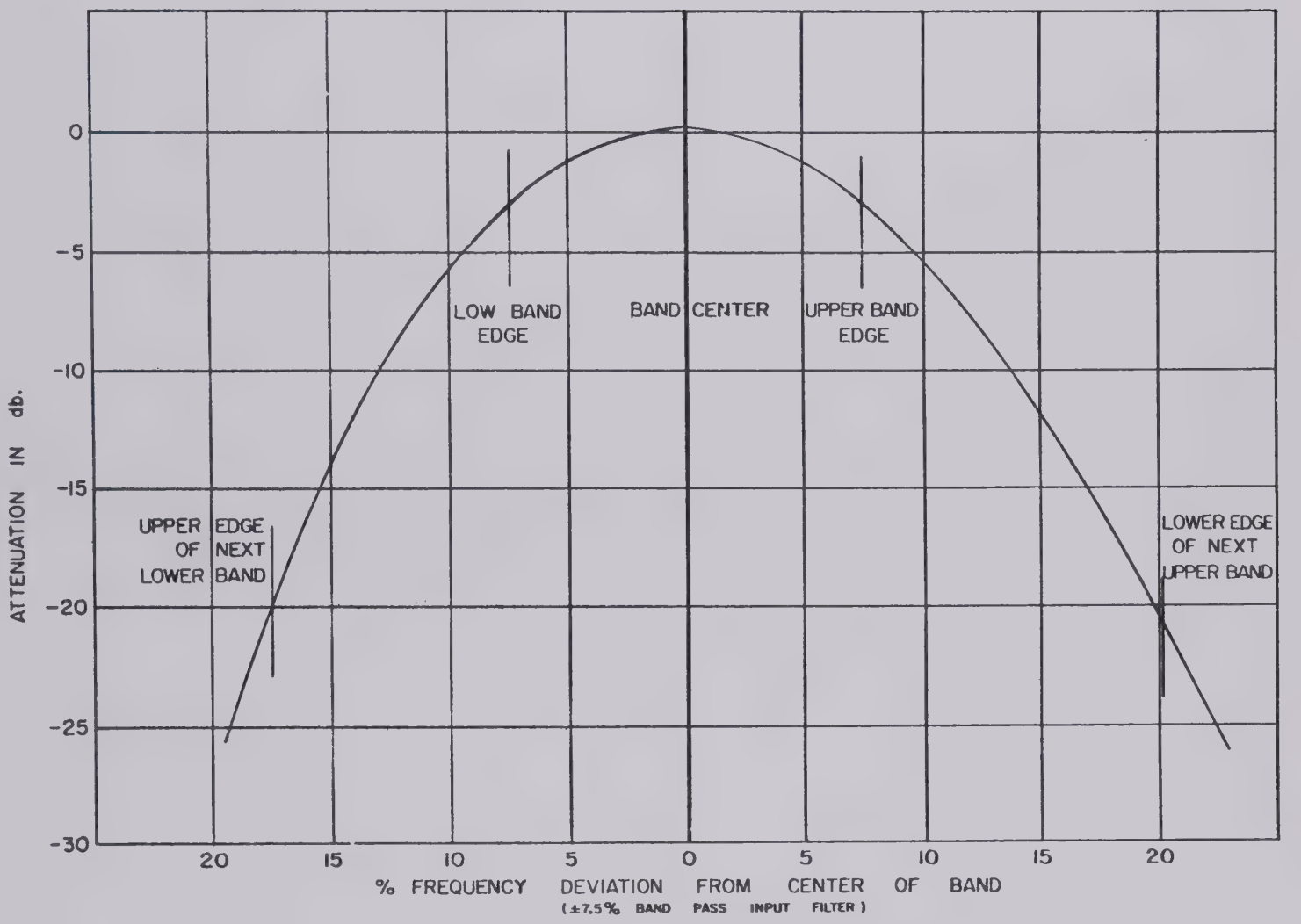


FIGURE III-2. TYPICAL BAND-PASS INPUT FILTER ATTENUATION

3.3 CHANNEL SELECTOR, BAND-PASS FILTER COMPONENTS

The Channel Selector Unit contains all components necessary to provide a band-pass input filter with the required attenuation and phase characteristics. These components are L-1101 through L-1104, C-1102, C-1104 through C-1106, R-1104, R-1106, R-1108 and R-1110. Bandwidth of ±7.5% and ±15% are normally provided, although other bandwidths can be supplied on order.

3.4 INPUT LEVEL METER

The input-level signal is applied to the rectifier bridge circuit formed by the diodes D-101 and D-102 and R-117 and R-118. This bridge is supplied from the low-impedance cathode of V-103B through the condenser C-103. Because of the large linear range of amplifier V-103, the meter will indicate limiting with deflections of the order of 1% of full scale. The linear range of this amplifier extends to approximately 85% of the meter scale. As V-103 saturates, the meter indication will approach full scale, but it cannot be damaged by large input signals.

3.5 LIMITER AND PULSE GENERATOR, V-201, V-202, V-203 AND V-301

The limiter circuit V-201, V-202, V-203 is designed to produce a square wave whose positive zero crossing occurs simultaneously with the positive input zero crossing of the input sine wave. The amplifier V-201 is designed to provide a large amplification of the input signal sine wave for plate excursions of approximately ±20 volts. Beyond this range one of the diodes of V-202 conducts and reduces the gain of amplifier V-201 to approximately unity, preventing any further large plate excursions. Thus, for limiting sine-wave signals, the signal on the plate of V-201 approximates a square wave whose sides coincide with the zero-axis crossing of the input sine wave. This square wave then triggers the cathode-coupled bistable mulivibrator V-203. The output of this trigger circuit is selected from the unloaded plate of V-203B, which because of the cathode coupling is free of capacity and therefore produces a good square wave.

Because this limiter circuit triggers only when the incoming sine wave crosses the zero axis, the output will not be affected by variations in input signal levels over the entire linear range of amplifier V-103. Since limiting occurs with between 0.4 and 1.0 volts rms on the plate of V-103B, and this amplifier remains linear to at least 35 volts rms, a dynamic input operating range of greater than 30 db is provided. This permits the limiter to reject large scale amplitude modulation almost completely. When the input signal to the grid of V-101 falls below approximately 5 millivolts, limiting will fail and the discriminator will become inoperative.

The output of the limiter is fed to V-301 through the pulse-forming circuit C-209 and R-301. Tube V-301 is biased beyond cutoff so that the negative grid pulses do not appear at the discriminator. Each positive grid pulse triggers the discriminator through the plate coupling of V-302.

3.6 TRIGGER-CIRCUIT DISCRIMINATOR, V-302, V-303, AND V-304

In the absence of pulses from V-301, the discriminator circuit is inoperative, with V-302 cut off and V-304 conducting by virtue of their respective grid- and cathode-return circuits. In this condition, diode V-303A conducts and the plate voltage of V-302 is fixed at approximately +100 volts through resistive divider R-307, R-310, and R-311. The cathode of V-303B is also maintained at +100 volts. The circuit passes through one cycle of operation for each trigger pulse from V-301, the pulse being applied directly to the plate of V-302 and through diode V-303A, cathode follower V-303B, and C-1306 to the control grid of V-304. The pulse applied to the grid of V-304 is maintained at constant amplitude because diode V-303A stops conducting when the plate of V-302 becomes more negative than −100 volts. With V-304 thus cut off, its plate rises to approximately +160 volts; this applies positive grid bias to V-302 through R-309. As V-302 conducts, its plate voltage drops to approximately −170 volts while the cathode of diode V-303A is maintained at approximately −100 volts by R-310 and R-311. The cathode of the cathode follower V-303B is also maintained at approximately −100 volts. The circuit remains in this condition until C-1306 discharges through R-1314 and R-1322 by an amount sufficient to start conduction of V-304. The circuit then returns abruptly to the initial condition, where it awaits the next pulse from V-301. Thus the ±100 volts on the cathode of V-303B corresponding to the two discriminator circuit conditions is dependent upon only the precision of resistors R-307, R-310, and R-311 and the stable B+ and B− voltages, and is not dependent upon the conduction characteristics of V-302 or V-304. Since V-301 and V-302 are completely cut off before a trigger pulse, these tubes do not affect the +100-volt condition of cathode follower V-303B. The filaments of V-303 are regulated to prevent variations in the cathode-follower output from V-303B.

The BALANCE control, R-1322, provides an adjustment of the output at center frequency by changing the time during which V-304 is saturated and V-302 is cut off following each trigger pulse.

3.7 CHANNEL SELECTOR, DISCRIMINATOR COMPONENTS

The channel selector contains all the components that establish operation at a given subcarrier center frequency with a corresponding intelligence pass band. The channel frequency is determined by C-1306, R-1314, and R-1322. Resistors R-1401 and R-1443 are the input resistors for the low-pass output filter circuit and determine the output sensitivity for a given intelligence pass-band.

3.8 LOW-PASS OUTPUT FILTER AMPLIFIER, V-401, V-402, V-403, V-404, V-405, AND V-406

The low-pass output filter (LPOF) amplifier consists of two cascaded computer-type operational amplifiers. The open-loop gain of each amplifier is approximately 90 db, providing highly stable amplification when the gain is adjusted, by means of the feedback components, to approximately unity. In addition, the filaments of the input tube to each amplifier (V-401 and V-403) are regulated.

The frequency-response and gain characteristics of the amplifiers are determined by the RC networks at the input to each amplifier. These consist of R-1443, R-1401 through R-1404 and C-1401 through C-1403 for the first amplifier (V-401 and V-402). The network for the second amplifier (V-403, V-404, V-405, and V-406) consists of R-1419 through R-1422 and C-1410 through C-1412 in addition to the feedback-divider networks included on the Output Gain control switch, SW-401. The RC networks shown in the schematic diagram are those that establish the characteristics of the low-pass output filter. Since all RC networks except the feedback-divider networks (which do not affect the frequency response) are included in the LPOF plug-in, other frequency and gain characteristics can be obtained by employing specific LPOF plug-ins.

The dc gain of each section of the output amplifier is determined approximately by the ratio of the feedback resistor to the input resistance divided by the amount of the output that is fed back. For the first amplifier the ratio is R-1404 to R-1401 plus R-1402, which is nearly 1; since all of the output is fed back, the dc gain of this section is unity. For the second section the ratio is R-1421 to R-1419 plus R-1420, again nearly unity, but here the amount of the output that is fed back is varied by the divider networks on SW-401 or by externally provided dividers. For example, in the highest gain position (position #5) and with R-447 full clockwise, the amount of output feedback is the ratio of R-446 to R-452 plus R-447, which is about 1:15.7. Thus the gain of the second section is approximately 15.7 in this position. The actual values of these feedback-divider resistors are such that the output is not excessively loaded.

Capacitors C-424 to C-428 are shunted across the upper legs of the feedback dividers to maintain stability of this output amplifier section. If external feedback-divider networks are used (EXT position of SW-401) capacitors having values similar to those used on SW-401 should be added.

The output stage of the second amplifier section operates with V-406 driven by V-404 as for a normal cathode follower, but V-405 replaces the usual passive cathode resistor with an active element. This permits large positive output voltages at currents up to 25 ma with a comparatively small current drain from the negative power supply because V-405 tends to cut off as the output goes positive. Conversely, the current through V-406 tends to decrease as the output goes negative to −90 volts, the added load current being drawn from the negative supply through V-405.

Diodes D-404 and D-405 in the first amplifier section are band-edge limiters. These diodes are biased at approximately ±140% of the band-edge voltage of the first amplifier section; thus they prevent the discriminator output from deviating more than ±140% of the band-edge voltage selected by SW-401 and R-447.

In the second amplifier section the bias supply required for the negative grid return of V-404 and V-405 is provided by rectifying the ac voltage on one winding of the B+ supply transformer, T1. Diode D-402 is a 100-volt zener diode used as a regulator to stabilize the bias supply at 100 volts below its B− return.

3.9 LOW-PASS OUTPUT FILTER AMPLIFIER EXTERNAL ZERO OFFSET

The output setting for band-center operation can be varied externally by injecting a voltage through R-1438 to the first section of the output amplifier. The voltage gain of the first amplifier section is approximately 1.5 when the input is applied through R-1438. Since any spurious signals appearing at this input will appear at the output, shielded cables must be used for this input.

3.10 LOW-PASS OUTPUT FILTER AMPLIFIER EXTERNAL GAIN CONTROL

The methode of externally varying the gain of the second amplifier section is identical to that used when varying the gain with controls SW-401 and R-447; i.e., the feedback-divider ratios are varied. In positions #1 through #5 of SW-401, either resistor leg of the dividers on SW-401 can be externally shunted with resistors. In the EXT position (position #6) of SW-401 the entire feedback divider must be provided externally. These two ways of externally controlling the gain are shown in Figure II-1.

3.11 LOW-PASS OUTPUT FILTER AMPLIFIER BALANCE ADJUSTMENT

If the gain of the second section of the output amplifier is varied as described above, an analysis of the feedback loop will show that the offset voltage remains constant with gain only when the voltage appearing at the feedback point of the feedback divider exactly equals the input voltage to the amplifier (at R-1419). For all other conditions, the difference between the input voltage and the feedback voltage is amplified, and varying the gain varies the amount of this difference appearing at the output. The input and feedback voltages can be equalized by adding a small voltage through R-1441. The amount is determined by referencing the input to ground through SW-402 and adjusting the added voltage from the potentiometer R-450 until the output is zero volts. In this condition the feedback voltage equals the input voltage.

3.12 OUTPUT METER

The Output meter, M-401, is connected to the feedback point of the second output amplifier section through R-408. The value of R-408 is such that for the condition of 100% feedback (i.e., SW-401 in position #1 and R-447 full counterclockwise) the output meter reads full scale for an input voltage to the second amplifier section corresponding to full-bandwidth deviation. Since the gain of this section is determined by the feedback-divider ratio, the voltage at the feedback point of the divider will remain the same as in the 100% case, independent of the divider ratio. Hence, the output meter always reads per cent deviation from band-center, independent of the output-amplifier gain determined by SW-401 and R-447.

3.13 CHANNEL SELECTOR, LOW-PASS OUTPUT FILTER COMPONENTS

The RC networks necessary to provide the proper frequency and gain characteristics for the low-pass output filter amplifier are contained in a separate insert

unit. In addition, resistor R-1438, through which the external zero offset is added, and resistor R-1441, through which the amplifier balance signal is added, are also included in this insert. This unit is normally inserted in the channel selector and held there by means of a quick-disconnect fastener. The channel selector is inserted in the front-panel opening of the discriminator chassis and held there by means of two screw fasteners.

The output sensitivity is adjusted for any given subcarrier pass-band deviation by the network consisting of R-1401 and R-1443. For example, for a ±7.5% channel, R-1401 is 100K and R-1443 is omitted; for a ±15% channel, R-1401 and R-1443 both are 200K in order to provide 50% attenuation of the signal appearing on the cathode of V-303B. In any case the impedance to C-1401 must be 100K.

This low-pass output filter amplifier serves several purposes: (1) It removes the subcarrier frequency from the intelligence. (2) By the choice of the proper intelligence frequency, it removes a great deal of the noise normally present in an FM/FM system. (3) It also provides a low-impedance output capable of driving most standard-type recording instruments.

Since the channel selector insert plug-in has leads to the Cannon connector on the discriminator chassis and to the low-pass output filter amplifier, either amplifier or both amplifiers can be employed as the low-pass output filter. This makes possible a variety of frequency and phase characteristics.

3.14 ZERO-SIGNAL CLAMPING CIRCUIT, V-305, AND ZERO-SIGNAL LIGHT

When the subcarrier signal is too small for normal operation of the discriminator, the discriminator circuit becomes inoperative and V-302 remains cut off. This is the "zero-signal" condition. Since the screen of V-302 is connected to ground through R-306, the screen is at zero potential when the tube is cut off. When V-302 is conducting, the screen drops to approximately −140 volts. Therefore, when the discriminator is being triggered by subcarrier signals, the screen potential averages approximately −70 volts. This screen voltage is applied through R-318 to the grid of V-305, the zero signal tube, the cathode of which is connected by resistive divider network R-316 and R-323 to a voltage that can be varied from zero to approximately −40 volts by means of resistor R-323. This adjustment can be made by rotating the ZERO SIGNAL BAL. control on the front panel of the discriminator.

Tube V-305 conducts when a zero signal is applied to the discriminator and the screen of V-302 rises to ground potential. A portion of the resulting screen current flows through the zero-signal light, an NE-2D neon bulb. The plate of V-305 is connected to the junction of R-1401 and R-1402 at the input of the low-pass output filter amplifier. In this condition the voltage drop across V-305 is less than 10 volts, which means that the input to the low-pass output filter amplifier is clamped to a voltage approximately 10 volts greater than is present on the cathode of V-305. When the discriminator is supplied with an input signal, however, the average 70-volt potential that the screen of V-302 approaches during

operation is sufficient to completely cut off the clamping tube, V-305. In this condition the plate impedance is nearly infinite and will not affect the operation of the low-pass output filter amplifier.

3.15 TAPE-SPEED COMPENSATION

The ground return of the discriminator time-constant-control resistor, R-1322, is connected to pin 22 of the Cannon connector at the rear of the discriminator. For normal operation this point is returned to ground by a jumper on the connector. However, tape recorder/reproducer speed-change-error compensation can be accomplished by connecting this point to the output of an EMR Model 96 Tape-Speed Compensator (12-channel) or an EMR Model 161 Tape-Speed Compensator (8-channel), either of which provides the necessary time-delay and amplitude adjustments.

3.16 POWER SUPPLY, D-1 through D-8, V-3, V-4, AND V-5

Transformer T-1 and silicon rectifiers D-1 through D-8 rectify the ac input voltage for the B+ and B− supplies. The two rectifier circuits are full-wave center-tap types using series diodes to achieve the necessary peak-inverse-voltage rating. Eight identical shunt resistors, R34 through R41, distribute the inverse voltage equally to prevent a single diode from being overloaded. Inductor L-1 and C-5 filter the rectified B− voltage prior to regulation while C-7 filters the B+ voltage. The B− voltage is filtered to a greater degree because the B+ regulator is referenced to the B− supply.

The B− supply is electronically regulated by V-5, V-6 and V-3B. V-5 supplies a fixed reference voltage for the regulator amplifier, V-6 and V-3B. Tube V-3B is the current regulator for the B− supply. The ripple content of the supply is extremely low due to a special bridge-balance circuit incorporated in the screen circuit of V-6B. Resistors R-21, R-22, R-23, R-24 and capacitor C-11 constitute this bridge circuit.

The B+ supply is similar to the B− with the exception that it is referenced from the B− supply. Tube V-5 supplies the reference for the B+ supply, and the cathode of V-4A is returned through R-3 to the B− supply. The ripple voltage of the B+ supply is nulled through the resistive divider network consisting of R-7, R-8, and R-9 in the screen circuit of V-4B. The filaments of both V-4 and V-6 are regulated to further increase the stability of the B+ and B− supplies.

The regulated filament windings for the Model 67D are supplied from the main power transformer, T-1. See Figure V-1. The regulated filament windings of the Model 67F must be supplied with power from an external 25-watt source of 115 volts ±1%, 55 to 70 cps. See Figure V-2.

SECTION IV
MAINTENANCE

4.1 INSPECTION

The Model 67 subcarrier discriminator should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. A complete inspection every six months should include the following:

a. Test all vacuum tubes.
b. Tighten all external screws.
c. Inspect wiring for loose connections and evidence of overheating.
d. Check all tube-socket voltages.
e. Check performance.
f. Replace defective components.

4.2 VOLTAGE MEASUREMENTS

All dc and ac voltage measurements may be made using the chassis ground as a reference. Tube socket voltages are given in Table IV-1.

4.3 PERFORMANCE TESTS

Most of the important characteristics of the discriminator may be determined by performing the tests described below. The inspection record may be used in connection with these tests. An audio-frequency oscillator, a vacuum-tube RMS voltmeter, an input attenuator, an oscilloscope, an accurate means for measuring 0 to 30 ma dc milliamperes and 0 to 100 volts dc and equipment to measure frequency to within 0.02% should be used in conducting these tests. An EMR Model 40C or Model 40D Frequency Calibrator is recommended as a signal source which meets the requirements for these tests. The set should be placed in operation in accordance with the conditions and the procedure outlined in Section II.

The physical layout including tubes and component cards is shown on drawings in Figures IV-1 and IV-2.

4.3.1 Amplifier Gain, Frequency Range and Distortion

With the Channel Selector removed, the signal from a low-impedance-source audio oscillator should be injected on the grid of V-103A (pin 8 of the Channel Selector plug). The gain of this amplifier is measured at the plate of V-103B. The gain should be approximately 20 and should be flat to about ±1 db over the frequency range of 400 cycles to 100 kc. Since the additional capacity of a measuring probe on the plate of V-103B will offset this response, it is best to check the amplifier by measuring the signal on the cathode of V-103B, i.e., the input monitor point. The amplifier should be linear up to 35 to 40 volts RMS output on the plate of V-103B, and this level should correspond to an INPUT LEVEL meter reading of approximately 85.

TABLE IV-1

TUBE SOCKET VOLTAGES MODEL 67 DISCRIMINATOR

Typical D-C Volts at Socket Pins with 115 Volts AC Input

TUBE	1	2	3	4	5	6	7	8	9
V-1	0	350	0	-1.8	0	-1	0	350	
V-2	0	117	0	-195	0	-195	0	115	
V-3	150	350	200	-22	90	0	0	0	
V-4	-110	-111	-4	-100	-100	0	-4	110	142
V-5	-111	-200		-200	-111		-200		
V-6	-110	-111	-88	-100	-100	-85	-88	-60	-22
V-101	200	89	90	0	0	200	89	90	0
V-102	200	90	91	0	0	200	0	2.5	0
V-103	130	0	2.7	-100	-100	-6.5	-183	-185	-100
V-201	-2.6	0	0	0	100	200	0		
V-202	25	-17	0	0	4.4	0	4.4		
V-203	100	135	0	0	2.5	9	22.5		
V-301	-195	-165	-100	-100	-40	0	-165		
V-302	-183	-174	-100	-100	-40	-61	-174		
V-303	-40	-40	0	0	0	195	0	0	0
V-304	--	-195	-100	-100	-62	-140	-195		
V-305	-70	-12	0	0	0	200	-12		
V-401	55	-0.8	0	0	0	90	-1	0	0
V-402	200	-1.8	100	0	0	110	0	-0.8	-8
V-403	0	-1.5	130	0	0	0	-1.7	55	100
V-404	-200	-195	-200	-200	-15	-26	-195		
V-405	-195	-200	-40	-200	-200	0	-195	-40	-200
V-406	0	0	200	200	-15	0	0	0	

AC Volts at Selected Socket Lugs (RMS)

V-1				310		310			
V-2				375		375			
V-103						26			

NOTES:

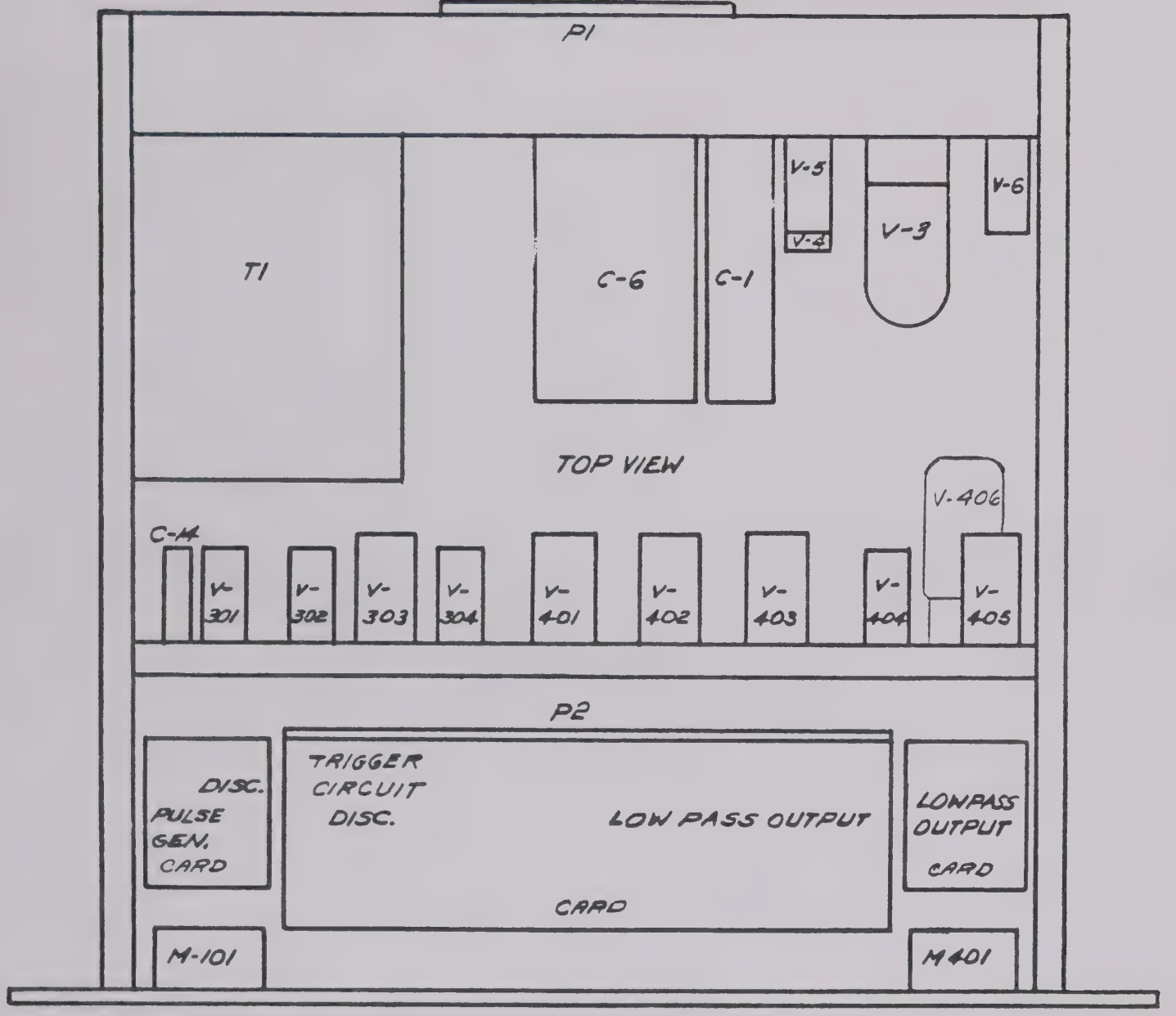
1. Voltages should be measured with equipment in normal operation with input level meter at center scale (50), and output centered to zero volts with the output gain at lowest value (±6). No output

load. Operation below 3.9 Kc is preferable to avoid stray effects due to the measuring probe. Input line voltage should be 115 volts RMS at 60 cps.

2. Vacuum tube voltmeters should be used for both a-c and d-c measurements. All readings are made from the point indicated to chassis ground.

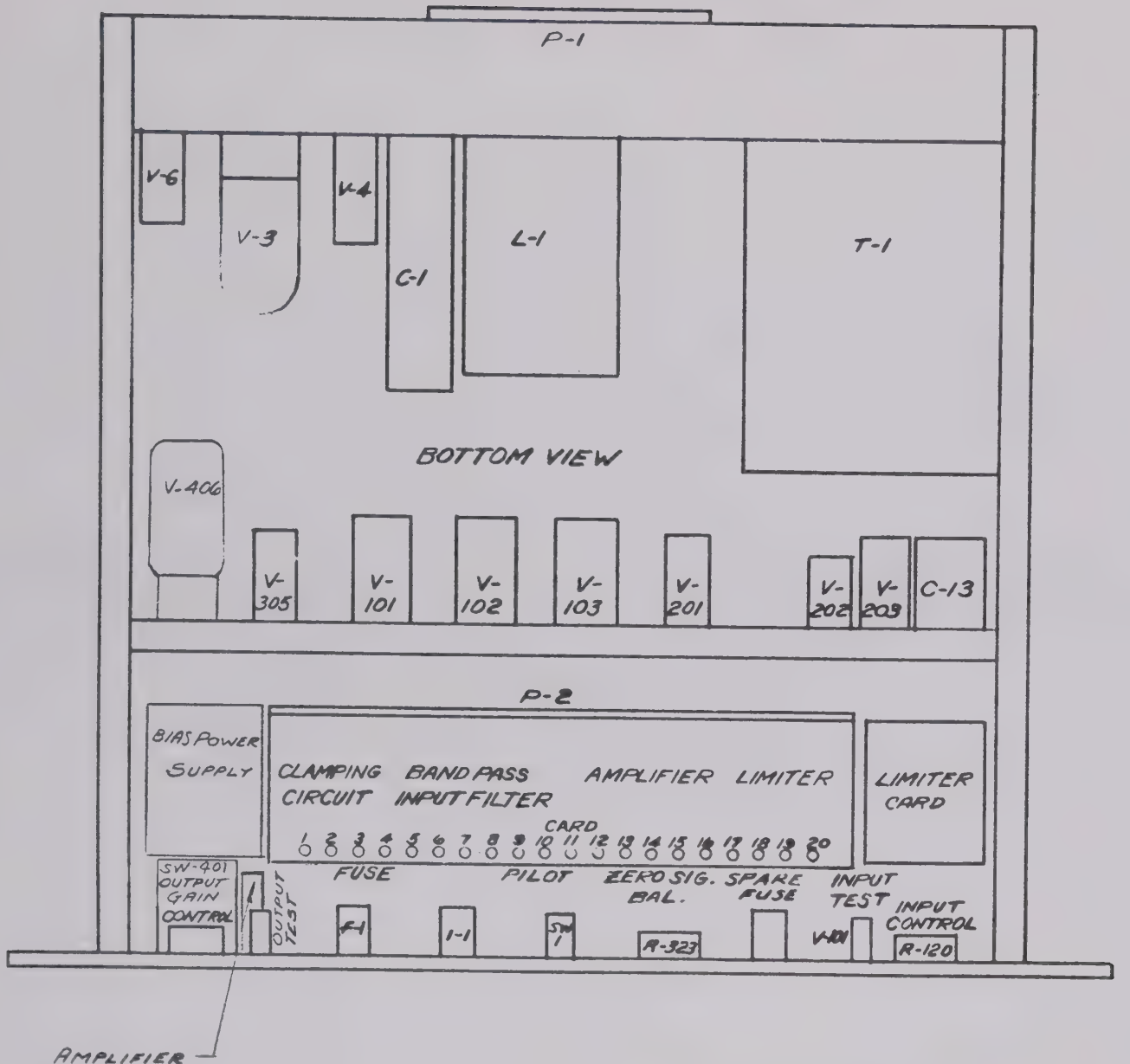
3. Design center value are indicated throughout and are subject to normal variations resulting from tube and component tolerances.

4. All heaters 6.3 volts A.C. except V-1 and V-2 which are 5.0 volts A.C.



V-3 - 6080
V-4 - 6AW8A
V-5 - 5651WA
V-6 - 6AW8A
V-301 - 6AU6
V-302 - 6AU6
V-303 - 6201
V-304 - 6136
V-401 - 12AY7
V-402 - 6U8
V-403 - 6AW8A
V-404 - 6AU6
V-405 - 6197
V-406 - 6L6GB

FIGURE IV-1. LOCATION OF COMPONENTS (TOP VIEW)
MODELS 67D AND 67F



V-3 - 6080
V-4 - 6AW8A
V-6 - 6AW8A
V-101 - 12AT7
V-102 - 12AT7
V-103 - 12AY7
V-201 - 6AU6
V-202 - 6AL5
V-203 - 5964
V-305 - 6AU6
V-406 - 6L6GB

FIGURE IV-2. LOCATION OF COMPONENTS (BOTTOM VIEW) MODELS 67D AND 67F

4.3.2 Band-Pass Input Filter Gain and Frequency Characteristics

With the input attenuator turned fully clockwise and a channel selector inserted in the discriminator, the voltage gain to the plate of V-103B should be in the range of from 100 to 400. The gain of the band-pass input filter as measured at the plate of V-103B should not be more than 4 db nor less than 2 db at either band edge as measured from the maximum gain point within the band. Also, the curve of attenuation vs. frequency should be reasonably symmetrical about the center frequency. At 20% deviation for the 7.5% channels and at 40% deviation for the 15% channels the gain should be down approximately 18 db from maximum. A typical attenuation vs. frequency characteristic curve is illustrated in Figure IV-3.

4.3.3 Band-Pass Input Filter Time-Delay Variation

The band-pass filter in the channel selector has been adjusted so that the total time-delay variation of the maximum intelligence frequency based upon a modulation index of 5 does not exceed 1.5^{o}. The allowable variation is inversely proportional to modulation index. It is necessary to achieve this degree of constancy in time delay of the intelligence in order to maintain the harmonic distortion of intelligence frequencies below cutoff at less than 0.5% and to achieve proper tape-speed-error compensation.

> CAUTION: The selection of the band-pass input filter components in the channel selector is critical. For this reason the channel selector should be returned to the factory when repair or adjustment is necessary.

4.3.4 Limiter Sensitivity

As the input level is decreased, no change should result in the output until the trigger generator ceases to function. This should occur at an input of 5 millivolts, or less, with a standard channel selector plugged into the discriminator.

4.3.5 Output Amplitude and Linearity for the Standard Channel Selector with a Standard Low-Pass Output Filter

The output for a ±7.5% or ±15% frequency deviation should be ±6.0 to ±6.9 volts with SW-401 in position #1 and R-447 full counterclockwise. The voltage ranges indicated on the front panel should be obtained approximately for each SW-401 position and proper rotation of R-447. Each range should provide overlap. Output variations from unit to unit for full deviation for a given position are caused largely by tolerances in the characteristics of V-303B and the values of the positive and negative supply voltages.

For channels in which the deviation is ±7.5% or ±15% of the subcarrier frequency, the linearity of output vs. frequency should be within ±0.1% of full bandwidth based on the best straight line. In order to measure the linearity to this degree of accuracy, the input frequency must be known to an accuracy of 0.02% and the

output-voltage-measuring device must be accurate to within 0.02%. In order to observe voltages to this degree of accuracy, a potentiometer-null method is recommended.

4.3.6 Low-Pass Output Filter Amplifier

The performance of the low-pass output filter amplifier can be checked by plugging into the discriminator only the low-pass output filter, not the complete channel selector. A signal can be injected from a low-impedance audio oscillator through a precision 100K resistor to pin 13 of the channel selector. For this test, zero-signal tube V-305 must be removed. The gain and frequency characteristics of the low-pass-output-filter amplifier can then be observed at the output (pin 7 or 8 of the Cannon connector). The standard-type low-pass output filter plug-in should provide a frequency response that is flat within ±0.5 db from dc to its nominal cutoff frequency. The Gaussian-type output filter has a response that is down no more than 3 db at cutoff.

Since the output amplifier consists of two sections, further performance testing can be accomplished by checking the output of the first section at cathode resistor R-418 (located on the component card opposite V-402). With a standard plug-in filter, the attenuation characteristics in db should be about one-half those of the complete amplifier.

A ±1-volt signal into the zero-offset input on pin 19 of the Cannon connector should produce approximately a ±1.5-volt output signal with SW-401 in position #1 and R-447 full counterclockwise.

The second section of the amplifier can be isolated by pushing in the Amplifier Balance control on the front panel. This returns the output to this section at R-1419 to ground through SW-402. Turning this control when it is pushed in varies the balance-voltage input to this section. The output thus can be varied approximately 60% of full range, not necessarily symmetrical about center.

4.3.7 Zero-Signal Circuit

The operation of this circuit can be checked by alternately applying and removing the subcarrier-signal input to the discriminator. If the circuit is operating properly, adjustment of R-323 will have no effect upon the output when a normal input is applied. When a zero-signal condition exists, adjustment of R-323 will affect the output, which can be set to any desired value as indicated on the OUTPUT meter.

4.3.8 Zero-Signal Light

Proper operation of the neon bulb can be checked by depressing the plastic cover of the indicator light. When a subcarrier signal sufficiently strong for proper operation is present at the input to the discriminator, the activation of this spring-loaded "press-to-test" switch has no effect upon discriminator operation because V-305 is cut off.

When the discriminator is in zero-signal condition and the zero-signal light glows, the station operator may accidentally depress the plastic cover of the zero-signal light. In such a case the activation of the "press-to-test" switch will cause the discriminator output to go beyond full scale.

4.3.9 Power Supply

The B+ and B– supply voltages can be observed at terminals 17 and 18 on the band-pass input filter card on the bottom of the discriminator chassis or at pin 16 or 17 of the Cannon connector. With no signal input to the discriminator, these voltages should be between 185 and 205 volts. The ac ripple voltage on either supply as measured with an rms voltmeter should be less than 4 millivolts. If the ripple voltage on either supply exceeds this level, V-4 and V-6 should be checked.

The regulation of the regulated filament windings should be noted on the appropriate circuit schematic (Figures V-1 and V-2).

The grid-bias supply for V-404 and V-405 should be about –100 volts with respect to B– at the junction of R-438 and D-402. About 0.15 volt rms of ripple may be observed at this point.

4.4 REPAIRS

The techniques for repairing the Model 67 Subcarrier Discriminator are similar to those employed with other electronic equipment. When a unit is not operating properly, the procedures outlined above will usually make possible the localization of the difficulty. The circuit wiring conforms to the color code listed in Table IV-2.

TABLE IV-2

WIRE COLOR CODE

BLACK	GROUND
VIOLET	B-
BROWN	FILAMENTS OFF GROUND
RED	B+
BLUE	PLATES
YELLOW	CATHODES
ORANGE	SCREENS
GREEN	GRIDS
SLATE	AC POWER LINES

SECTION V
DRAWINGS

Fig. No.	Title
V-1	Schematic Diagram Model 67D
V-2	Schematic Diagram Model 67F

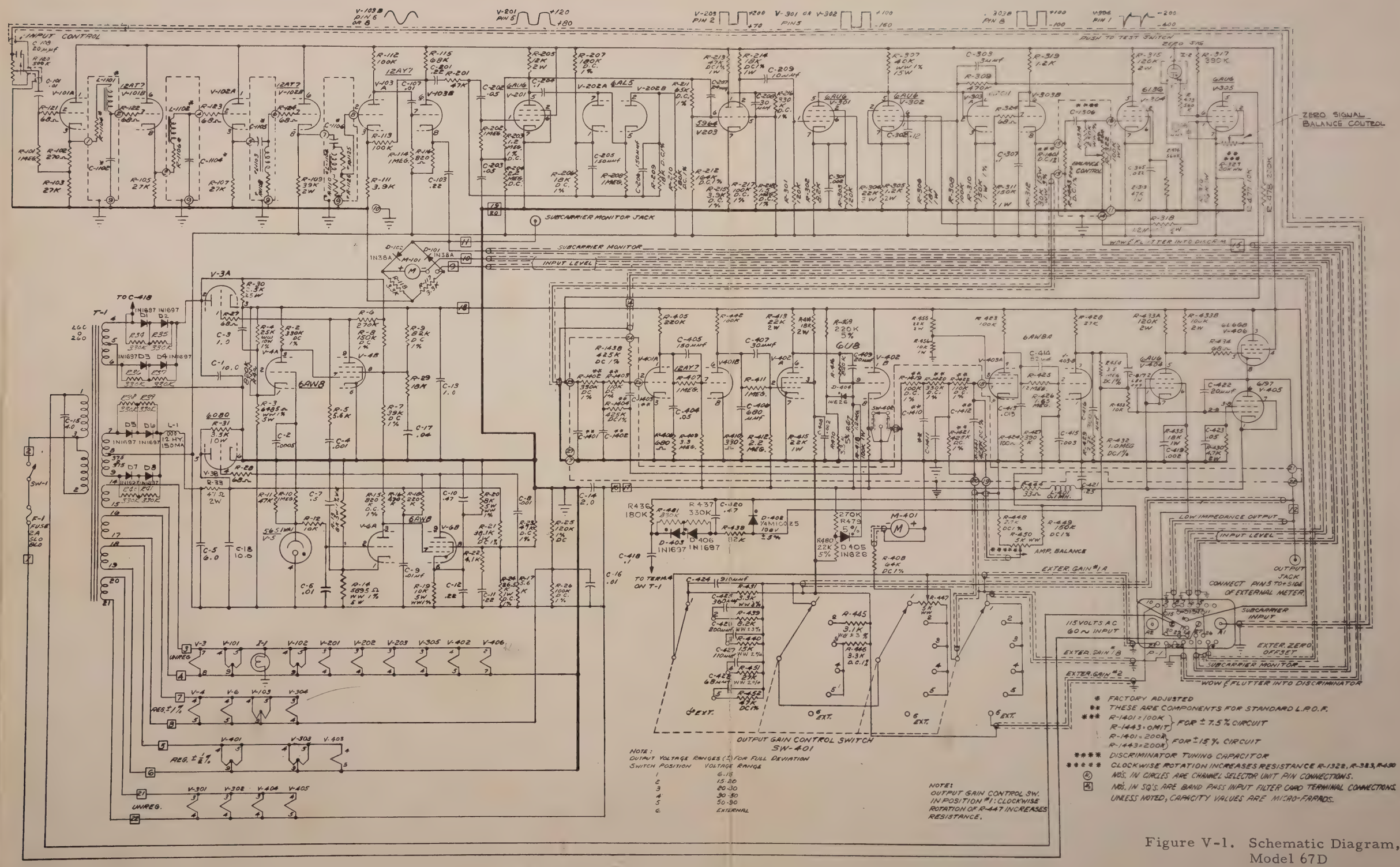

INPUT CONTROL
PUSH TO TEST SWITCH
ZERO SIG.
ZERO SIGNAL BALANCE CONTROL
SUBCARRIER MONITOR JACK
SUBCARRIER MONITOR
INPUT LEVEL
WOW & FLUTTER INTO DISCRIM.
TO C-418
OUTPUT GAIN CONTROL SWITCH SW-401
LOW IMPEDANCE OUTPUT
INPUT LEVEL
OUTPUT JACK
CONNECT PIN 5 TO + SIDE OF EXTERNAL METER.
AMP. BALANCE
SUBCARRIER INPUT
EXTER. ZERO OFFSET
SUBCARRIER MONITOR
WOW & FLUTTER INTO DISCRIMINATOR
115 VOLTS AC 60 ~ INPUT
EXTER. GAIN #1A
EXTER. GAIN #1B
EXTER. GAIN #2
OUTPUT GAIN CONTROL SWITCH SW-401
UNREG.
REG. ±1%
REG. ±1/2%
NOTE: OUTPUT VOLTAGE RANGES (±) FOR FULL DEFLECTION
Switch Position / Voltage Range
1 6-18
2 15-30
3 30-60
4 60-150
5 150-300
6 EXTERNAL
NOTE: OUTPUT GAIN CONTROL SW. IN POSITION #1: CLOCKWISE ROTATION OF R-447 INCREASES RESISTANCE.
* FACTORY ADJUSTED
** THESE ARE COMPONENTS FOR STANDARD L.R.O.P.
*** R-1401 = 100K, R-1443 = 0 MIT } FOR ±7.5% CIRCUIT
R-1401 = 200K, R-1443 = 200K } FOR ±15% CIRCUIT
**** DISCRIMINATOR TUNING CAPACITOR
***** CLOCKWISE ROTATION INCREASES RESISTANCE R-1328, R-383, R-430
(#) NOS. IN CIRCLES ARE CHANNEL SELECTOR UNIT PIN CONNECTIONS.
[#] NOS. IN SQ'S. ARE BAND PASS INPUT FILTER CORD TERMINAL CONNECTIONS.
UNLESS NOTED, CAPACITY VALUES ARE MICRO-FARADS.

Figure V-1. Schematic Diagram, Model 67D

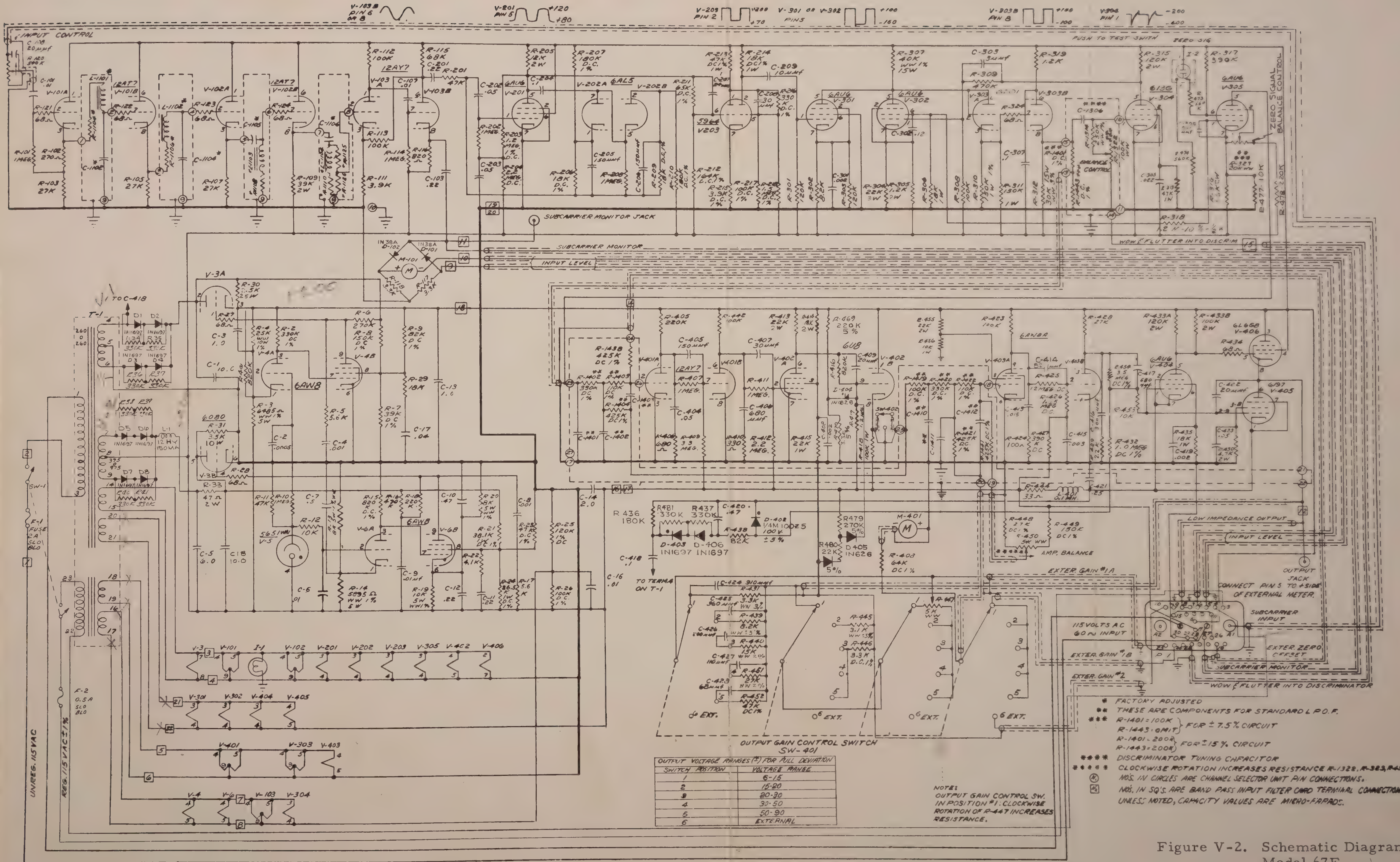

INPUT CONTROL
SUBCARRIER MONITOR JACK
SUBCARRIER MONITOR
INPUT LEVEL
PUSH TO TEST SWITCH
ZERO SIG
ZERO SIGNAL BALANCE CONTROL
BALANCE CONTROL
WOW & FLUTTER INTO DISCRIM
LOW IMPEDANCE OUTPUT
AMP. BALANCE
EXTER. GAIN #1A
EXTER. GAIN #1B
EXTER. GAIN #2
115 VOLTS AC 60 ~ INPUT
OUTPUT JACK
CONNECT PIN 5 TO + SIDE OF EXTERNAL METER.
SUBCARRIER INPUT
EXTER. ZERO OFFSET
SUBCARRIER MONITOR
WOW & FLUTTER INTO DISCRIMINATOR
UNREG. 115 VAC
REG. 115 VAC ± 1%
TO TERM. 4 ON T-1
OUTPUT GAIN CONTROL SWITCH SW-401
OUTPUT VOLTAGE RANGES (±) FOR FULL DEVIATION
SWITCH POSITION / VOLTAGE RANGE
1 6-15
2 15-20
3 20-30
4 30-50
5 50-90
6 EXTERNAL
NOTE: OUTPUT GAIN CONTROL SW. IN POSITION #1: CLOCKWISE ROTATION OF R-447 INCREASES RESISTANCE.
* FACTORY ADJUSTED
** THESE ARE COMPONENTS FOR STANDARD L.P.O.F.
*** R-1401 = 100K, R-1443 = OMIT } FOR ± 7.5% CIRCUIT
R-1401 = 200K, R-1443 = 200K } FOR ± 15% CIRCUIT
**** DISCRIMINATOR TUNING CAPACITOR
***** CLOCKWISE ROTATION INCREASES RESISTANCE R-1322, R-323, R-450
(N) NOS. IN CIRCLES ARE CHANNEL SELECTOR UNIT PIN CONNECTIONS.
[N] NOS. IN SQ'S. ARE BAND PASS INPUT FILTER CARD TERMINAL CONNECTIONS.
UNLESS NOTED, CAPACITY VALUES ARE MICRO-FARADS.

Figure V-2. Schematic Diagram, Model 67F

SECTION VI

REPLACEABLE PARTS

6.1 PARTS LIST

This section contains the Replaceable Parts Lists for the Models 67D and 67F Subcarrier Discriminator.

Model 67 Discriminator Replaceable Parts

Symbol	Description	Manufacturer	Type and Tolerance		Function
R-1	100 Ohms	Dale	B-25	10%	A-C Ripple Filter
R-2	330 K	Electra	DC-1/2c	1%	B+ Supply 1st Amp. Plate Load
R-3	6485 Ohms	Dale	RS-5	1%	B+ Supply 1st Amp. Cathode Bias Divider
R-4	25 K	Dale	RS-10	1%	B+ Supply 1st Amp. Cathode Bias Divider
R-4A	820 K	Allen-Bradley	EB	10%	R-4 Shunt Resistor
R-5	5.6 K	Allen-Bradley	EB	10%	B+ Regulator Stabilizing Network
R-6	270 K	Allen-Bradley	EB	10%	B+ Supply 2nd Amp. Plate Load
R-7	39 K	IRC	MDC	1%	B+ Supply 2nd Amp. Screen Ripple Bridge
R-8	150 K	IRC	MDC	1%	B+ Supply 2nd Amp. Screen Ripple Bridge
R-9	82K	IRC	MDC	1%	B+ Supply 2nd Amp. Screen Ripple Bridge
R-10	1.0 Megohm	Allen-Bradley	EB	10%	B+ Supply 1st Amp. Grid Isolation
R-11	47 K	Allen-Bradley	EB	10%	Reference Tube Current Limiting
R-12	10 K	Allen-Bradley	EB	10%	B- Supply 1st Amp. Grid Isolation
R-13	8 K	Dale	RS-5	1%	B- Supply 1st Amp. Cathode Bias
R-14	5895 Ohms	Dale	RS-5	1%	B- Supply 1st Amp. Cathode Bias
R-15	820 K	Electra	DC-1/2c	1%	B- Supply 1st Amp. Plate Load
R-16	470 K	Allen-Bradley	EB	10%	B- Supply 2nd Amp. Plate Decoupling
R-17	5.6 K	Allen-Bradley	EB	10%	B- Supply Regulator Stabilizing Network
R-18	220 K	Allen-Bradley	EB	10%	B- Supply 2nd Amp. Plate Load
R-19	10 K	Dale	RS-5	1%	B- Supply 2nd Amp. Cathode Bias Divider
R-20	8 K	Dale	RS-5	1%	B- Supply 2nd Amp. Cathode Bias Divider
R-21	38.1 K	Electra	DC-1	1%	B- Supply 2nd Amp. Screen Ripple Bridge
R-22	4.1 K	Electra	DC-1/2c	1%	B- Supply 2nd Amp. Screen Ripple Bridge
R-23	47 K	IRC	MDC	1%	B- Supply 2nd Amp. Screen Ripple Bridge
R-24	26.5 K	Electra	DC-1	1%	B- Supply 2nd Amp. Screen Ripple Bridge
R-25	120 K	IRC	MDC	1%	Heater DC Voltage Reference Divider
R-26	100 K	IRC	MDC	1%	Heater DC Voltage Reference Divider
R-27	68 Ohms	Allen-Bradley	EB	10%	B+ Supply Parasitic Suppressor
R-28	68 Ohms	Allen-Bradley	EB	10%	B- Supply Parasitic Suppressor
R-29	18 K	Allen-Bradley	EB	10%	B+ Supply 2nd Amp. Screen Ripple Bridge
R-30	5.5 K	Sage	S5W	3%	B+ Regulator Shunt
R-31	5.5 K	Sage	S5W	3%	B- Regulator Shunt
R-101	1. Megohm	Allen-Bradley	EB	10%	1st Filter-Amp. Grid Return
R-102	270 Ohms	Allen-Bradley	EB	10%	1st Filter-Amp. Cathode Voltage Divider

Symbol	Description	Manufacturer	Type and Tolerance		Function
R-103	27 K	Allen-Bradley	EB	10%	1st Filter-Amp. Cathode Voltage Divider
R-1104	See Channel Selector Parts List				
R-105	27 K	Allen-Bradley	EB	10%	2nd Filter-Amp. Cathode Bias
R-1106	See Channel Selector Parts List				
R-107	27 K	Allen-Bradley	EB	10%	3rd Filter-Amp. Cathode Bias
R-1108	See Channel Selector Parts List				
R-109	39 K	Allen-Bradley	HB	10%	4th Filter-Amp. Cathode Bias
R-1110	See Channel Selector Parts List				
R-111	3.9 K	Allen-Bradley	EB	10%	1st Amplifier Cathode Bias
R-112	100 K	Allen-Bradley	EB	10%	1st Amplifier Plate Load
R-113	100 K	Allen-Bradley	EB	10%	1st Amplifier Plate Cathode Feedback
R-114	1.0 Megohm	Allen-Bradley	EB	10%	2nd Amplifier Grid Return
R-115	68 K	Allen-Bradley	EB	10%	2nd Amplifier Plate Load
R-116	820 Ohms	Allen-Bradley	EB	10%	2nd Amplifier Cathode Bias
R-117	3.3 K	Allen-Bradley	EB	10%	Input Level Meter Bridge
R-118	3.3 K	Allen-Bradley	EB	10%	Input Level Meter Bridge
R-119	Not used				
R-120	500 K	Ohmite	CA-5041		Input Level Control
R-121	68 Ohms	Allen-Bradley	EB	10%	Band Pass Filter Parasitic Suppressor
R-122	68 Ohms	Allen-Bradley	EB	10%	Band Pass Filter Parasitic Suppressor
R-123	68 Ohms	Allen-Bradley	EB	10%	Band Pass Filter Parasitic Suppressor
R-124	68 Ohms	Allen-Bradley	EB	10%	Band Pass Filter Parasitic Suppressor
R-1125	*	Electra	DC-1/2c	1%	Band Pass Filter Gain Adjust
R-1126	*	Allen-Bradley	EB	10%	Band Pass Filter Gain Adjust
R-201	47 K	Allen-Bradley	EB	10%	Limiter Input Isolation
R-202	1 Megohm	Allen-Bradley	EB	10%	Limiter Input Grid Isolation
R-203	1.2 Megohm	Electra	DC-1/2A	1%	Limiter Plate-Grid Divider
R-204	2.2 Megohm	Electra	DC-1/2A	1%	Limiter Plate-Grid Divider
R-205	12 K	Allen-Bradley	HB	10%	Limiter Plate Load
R-206	18 K	IRC	MDC	1%	1st Limiter-Diode Cathode Bias Divider
R-207	180 K	IRC	MDC	1%	1st Limiter-Diode Cathode Bias Divider
R-208	1 Megohm	Allen-Bradley	EB	10%	2nd Limiter-Diodes D.C. Return
R-209	18 K	IRC	MDC	1%	2nd Limiter-Diodes Plate Bias Divider
R-210	180 K	IRC	MDC	1%	2nd Limiter-Diodes Plate Bias Divider
R-211	65 K	IRC	MDC	1%	Trigger Input Grid Bias Divider

*Used on 7.5% units only, Value Factory Adjusted.

Symbol	Description	Manufacturer	Type and Tolerance		Function
R-212	164 K	IRC	MDC	1%	Trigger Input Grid Bias Divider
R-213	47 K	Electra	DC-1	1%	1st Section Trigger Plate Load
R-214	18 K	Electra	DC-1	1%	2nd Section Trigger Plate Load
R-215	3.9 K	IRC	MDC	1%	Trigger Cathode Bias
R-216	330 K	Electra	DC-1/2c	1%	Trigger Plate-Grid Coupling
R-217	100 K	IRC	MDC	1%	2nd Section Trigger Grid Bias Divider
R-218	1.5 Megohms	Electra	DC-1/2A	1%	2nd Section Trigger Grid Bias Divider
R-301	120 K	Allen-Bradley	EB	10%	Pulse Generator Grid Return
R-302	8.2 K	Allen-Bradley	EB	10%	Pulse Generator Cathode Divider
R-303	120 K	Allen-Bradley	EB	10%	Pulse Generator Cathode Divider
R-304	22 K	Allen-Bradley	HB	10%	Discriminator Cathode Divider
R-305	1.2 K	Allen-Bradley	GB	10%	Discriminator Cathode Divider
R-306	18 K	Allen-Bradley	GB	10%	Discriminator Screen Voltage Dropping
R-307	40 K	Mepco	P-15	1%	Discriminator Plate Load
R-308	100 K	Allen-Bradley	EB	10%	Discriminator Grid Return
R-309	470 K	Allen-Bradley	EB	10%	Discriminator Plate to Grid Coupling
R-310	150 K	Eastern Prec. Res.	NS-6ALOC	1%	Cathode Bias Divider
R-311	150 K	Eastern Prec. Res.	NS-6ALOC	1%	Cathode Bias Divider
R-312	30 K	Mepco	P-15	3%	Discriminator Output Cathode Bias
R-313	47 K	Allen-Bradley	GB	10%	Discriminator Screen Dropping
R-1314	See Channel Selector Parts List				
R-315	120 K	Allen-Bradley	HB	10%	Plate Load
R-316	75 K	Electra	DC-1	1%	Clamper Cathode Divider
R-317	820 K	Electra	DC - 1/2c	1%	Clamper Screen Voltage Dropping
R-318	1.2 Meg	Allen-Bradley	EB	10%	Clamper Grid Isolation
R-319	1.2 K	Allen-Bradley	EB	10%	Discriminator Plate Isolation
R-320	Not Used				
R-321	Not Used				
R-1322	See Channel Selector Parts List				
R-323	20 K	Clarostat	49		Zero Signal Central Control
R-324	68 Ohms	Allen-Bradley	EB	10%	Discriminator Parasitic Suppressor

Symbol	Description	Manufacturer	Type & Tolerance		Function
R-1401	See Channel Selector Insert Parts List				
R-1402	See Low Pass Filter Insert Parts List				
R-1403	See Low Pass Filter Insert Parts List				
R-1404	See Low Pass Filter Insert Parts List				
R-405	220 K	Allen-Bradley	EB	10%	1st Output Amp. Stage Plate Load
R-406	680 Ohms	Allen-Bradley	EB	10%	1st Output Amp. Stage Stabilizer Network
R-407	1.0 Megohm	Allen-Bradley	EB	10%	Output Amp. Stage Plate-Grid Coupling
R-408	64 K	IRC	MDC	1%	Output Meter Series Load
R-409	3.3 Megohms	Allen-Bradley	EB	10%	2nd Output Amp. Stage Grid Divider
R-410	330 Ohms	Allen-Bradley	EB	10%	2nd Output Amp. Stage Stabilizer Network
R-411	1.0 Megohms	Allen-Bradley	EB	10%	2nd Output Amp. Stage Plate-Grid Coupling Divider
R-412	2.2 Megohms	Allen-Bradley	EB	10%	3rd Output Amp. Stage Grid Divider
R-413	22 K	Allen-Bradley	GB	10%	3rd Output Amp. Stage Plate Load
R-414	18 K	Allen-Bradley	GB	10%	3rd Output Amp. Stage Screen Divider
R-415	22 K	Allen-Bradley	GB	10%	3rd Output Amp. Stage Screen Divider
R-416	820 K	Allen-Bradley	EB	10%	3rd Output Amp. Stage Plate-Grid Coupling Divider
R-417	1.2 Megohms	Allen-Bradley	EB	10%	4th Output Amp. Stage Grid Return
R-418	100 K	Allen-Bradley	GB	10%	4th Output Amp. Stage Cathode Bias
R-1419	See Low Pass Filter Insert Parts List				
R-1420	See Low Pass Filter Insert Parts List				
R-1421	See Low Pass Filter Insert Parts List				
R-1422	See Low Pass Filter Insert Parts List				
R-423	100 K	Allen-Bradley	EB	10%	5th Output Amp. Stage Plate Load
R-424	1.8 K	Allen-Bradley	EB	10%	5th Output Amp. Stage Stabilizer Network
R-425	1.2 Megohms	Electra	DC 1/2A	1%	5th Output Amp. Stage Plate-Grid Coupling Divider
R-426	1.65 Megohms	Electra	DC 1/2C	1%	6th Output Amp. Stage Grid Divider
R-427	390 K	Electra	DC 1/2C	1%	6th Output Amp. Stage Grid Divider
R-428	27 K	Allen-Bradley	GB	10%	6th Output Amp. Stage Plate Load
R-429	3.3 K	Allen-Bradley	EB	10%	6th Output Amp. Stage Stabilizer Network
R-430	4.7 K	Allen-Bradley	HB	10%	8th Output Amp. Stage Screen Dropping
R-431	3.3 K	Sage	S5W	3%	Output Attenuator Element, 6.6-15v Position
R-432	1 Meg	Electra	DC 1/2C	1%	6th Output Amp. Stage Voltage Divider
R-433A	120 K	Allen-Bradley	HB	10%	7th Output Amp. Stage Plate Load
R-433B	100 K	Allen-Bradley	HB	10%	7th Output Amp. Stage Plate Load
R-434	68 Ohms	Allen-Bradley	EB	10%	Cathode Follower Output Amp. Parasitic Suppressor
R-435	18 K	Allen-Bradley	GB	10%	7th Output Amp. Stage Screen Dropping

Symbol	Description	Manufacturer	Type and Tolerance		Function
R-436	180 K	Allen-Bradley	EB	10%	B- Power Supply Bleeder
R-437	220 K	Allen-Bradley	EB	10%	AC Ripple Filter
R-438	82 K	Allen-Bradley	EB	10%	AC Ripple Filter
R-1438	See Low Pass Filter Insert Parts List				
R-439	8.2 K	Ohmite	3W	3%	Output Attenuator Element 15-20v Position
R-440	15 K	Precision Res. Co.	SX1816	2%	Output Attenuator Element 20-30v Position
R-1441	See Low Pass Filter Insert Parts List				
R-442	100 K	Allen-Bradley	EB	10%	2nd Output Amp. Plate Load
R-1443	See Channel Selector Parts List				
R-444	33 Ohms	Allen-Bradley	EB	10%	B- De-coupling Resistor
R-445	3.1 K	Ohmite	3W	3%	Output Filter Feedback Divider
R-446	3.3 K	IRC	MDC	1%	Output Filter Feedback Divider
R-447	5. K	Centralab			Output Attenuator for Fine Control
R-448	2.7 K	IRC	MDC	1%	Amplifier Balance Divider Element
R-449	150 K	Electra	DC-1/2c	1%	Amplifier Balance Divider Element
R-450	5 K	Clarostat	49		Output Amplifier Balance Control
R-451	27 K	Precision Res. Co.	SX-1510	2%	Output Attenuator Element 30-50v. Position
R-452	47 K	IRC	MDC	1%	Output Attenuator Element 50-90v. Position
R-453	10 K	Allen-Bradley	EB	10%	Output Amplifier Grid Resistor
R-454	3.5 Meg	Electra	DC-1/2c	1%	6th Output Amp. Stage Voltage Divider
R-455	22 K	Allen-Bradley	HB	10%	6th Output Amp. Stage Screen Divider
R-456	10 K	Allen-Bradley	GB	10%	6th Output Amp. Stage Screen Divider
R-469	390 K	Electra	DC-1/2c	1%	Voltage Divider for Diode Limiter
R-470	6 K	Electra	DC-1/2c	1%	Voltage Divider for Diode Limiter
R-473	560 K	Allen Bradley	EB	10%	Zero Signal Light Current Limiter
R-474	560 K	Allen Bradley	EB	10%	Zero Signal Light Test Circuit
D-101	IN38A/IN58A	Sylvania			Input Meter Bridge Rectifier
D-102	IN38A/IN58A	Sylvania			Input Meter Bridge Rectifier
D-402	IN1998A	U.S. Semi Conductor Products	100v	±5%	Bias Power Supply Regulator
D-403	9GA20	Intern'l Res. Corp.			Bias Power Supply Rectifier

Symbol	Description	Manufacturer	Type and Tolerance	Working Voltage	Function
C-1	10.0 Mfd.	Sprague	CP70B1FF106V	600	Unregulated B+ Filter
C-2	.0005 Mfd.	El-Menco	CM-15E-501J 5%	300	B+ Supply 1st Amp. Grid Decoupling
C-3	1.0 Mfd.	Pyramid	7PGIHL4-1	400	B+ Supply 1st Amp. Cathode Coupling
C-4	.001 Mfd.	El-Menco	CM19B-102K 10%	500	B+ Supply Regulator Stabilizer Network
C-5	6.0 Mfd.	Sprague	CP70B1FF605V	600	Unregulated B- Filter
C-6	.01 Mfd.	El-Menco	CM35B-103K 5%	500	B- Supply 1st Amp. Grid Decoupling
C-7	.5 Mfd.	Sprague	CP54-B1-EE-504M	400	B- Supply 1st Amp. Cathode Coupling
C-8	.001 Mfd.	El-Menco	CM19B-102K 10%	500	B- Supply Regulator Stabilizer Network
C-9	.01 Mfd.	El-Menco	CM35B-103K 10%	500	B- Supply 2nd Amp. Plate Decoupling
C-10	.47 Mfd.	Pyramid	7PGH	300	B- Supply 2nd Amp. Cathode Bypass
C-11	.22 Mfd.	Pyramid	PGH	200	B- Supply Screen Bridge Network
C-12	.22 Mfd.	Pyramid	PGIH	200	B- Supply 2nd Amp. Cathode Bypass
C-13	1.0 Mfd.	Tobe	OMB-401 20%	400	Regulated B+ Supply Filter
C-14	2.0 Mfd.	Tobe	OMB-402 20%	400	Regulated B- Supply Filter
C-15	4.0 Mfd.	Cornell-Dubilier	KC3040-15	300 AC	Power Transformer Primary Tuning Part of T-1 for Model D only
C-16	.01 Mfd.	El-Menco	CM35B-103K 10%	500	Regulated Filaments Bypass
C-17	.039 Mfd.	Pyramid	PGH --	200	B+ Supply Screen Stabilizing Network
C-101	.01 Mfd.	El Menco	CM35B-103K 10%	500	Input Coupling
C-1102	See Channel Selector Parts List				
C-103	.22 Mfd.	Pyramid	7EPGIH 20%	300	Coupling to Monitor Circuits
C-1104	See Channel Selector Parts List				
C-1105	See Channel Selector Parts List				
C-1106	See Channel Selector Parts List				
C-107	.01 Mfd.	El-Menco	CM35B-103K 10%	500	1st Amp. Plate-Grid Coupling
C-108	20 Mmf.	El-Menco	CM15C-200J 5%	500	Input Potentiometer Capacity Compensation
C-201	.22 Mfd.	Pyramid	EPGIH 20%	200	2nd Amp. Output Coupling
C-202	.05 Mfd.	Pyramid	EPGIH 20%	200	Limiter Input Coupling
C-203	.05 Mfd.	Pyramid	EPGH 20%	200	Limiter Grid Divider Decoupling
C-204	.1 Mfd.	Pyramid	EPGIH 20%	300	Limiter Grid-Diode Plate Cathode Coupling
C-205	.00015 Mfd.	El-Menco	CM15E-151J 5%	500	Limiter Diode Positive Peak Coupling
C-206	.00015 Mfd.	El-Menco	CM15E-151J 5%	500	Limiter Diode Negative Peak Coupling
C-207	24. Mmf.	El-Menco	CM15E-240J 5%	500	Trigger Input Grid Coupling
C-208	30. Mmf.	El-Menco	CM15E-300J 5%	500	Trigger Plate-Grid Coupling
C-209	10. Mmf.	El-Menco	CM15C-100J 5%	500	Pulse Generator Grid Coupling

Symbol	Description	Manufacturer	Type and Tolerance		Working Voltage	Function
C-301	.002 Mfd.	El-Menco	CM20B-202K	10%	500	Pulse Generator Cathode Bypass
C-302	.12 Mfd.	Pyramid	7PGIH	20%	300	Discriminator Screen Bypass
C-303	3. Mmf.	El-Menco	CM15E-030M	20%	300	Discriminator Feedback
C-304	Not Used					
C-305	.022 Mfd.	Pyramid	PGIHV	20%	300	V-304 Screen Bypass
C-1306	See Channel Selector Parts List					
C-307	.1 Mfd.	Pyramid	7PGIM	20%	600	Frequency Output Plate Decoupling
C-1401	See Low Pass Filter Insert Parts List					
C-1402	See Low Pass Filter Insert Parts List					
C-1403	See Low Pass Filter Insert Parts List					
C-404	.05 Mfd.	Pyramid	EPGIH	20%	300	1st Output Amp. Stage Stabilizer Network
C-405	.00015 Mfd.	El-Menco	CM15E-151J	5%	500	1st Output Amp. Stage Plate Grid Coupling
C-406	.00068 Mfd.	El-Menco	CM19B-681K	10%	500	2nd Output Amp. Stage Stabilizer Network
C-407	30. Mmf.	El-Menco	CM15E-300J	5%	500	2nd Output Amp. Stage Plate-Grid Coupling
C-408	.002 Mfd.	El-Menco	CM20B-202K	10%	500	3rd Output Amp. Screen Stage Decoupling
C-409	20. Mmf.	El-Menco	CM15C-200J	5%	500	3rd Output Amp. Stage Plate-Grid Coupling
C-1410	See Low Pass Filter Insert Parts List					
C-1411	See Low Pass Filter Insert Parts List					
C-1412	See Low Pass Filter Insert Parts List					
C-413	.0039 Mfd.	El-Menco	CM30-B-392-K	10%	300	5th Output Amp. Stage Stabilizer Network
C-415	.003 Mfd.	El-Menco	CM30B-302K	10%	500	6th Output Amp. Stage Grid Return Divider Decoupling
C-416	.001 Mfd.	El-Menco	CM19B-102-K	10%	300	6th Output Amp. Stage Stabilizer Network
C-417	680 MMfd.	El-Menco	CM19B-681-K	10%	600	6th Output Amp. Stage Plate-Grid Coupling
C-418	.1 Mfd.	Pyramid	7PGIM	20%	600	Bias Power Supply AC Coupling
C-419	.002 Mfd.	El-Menco	CM20B-202K	10%	500	7th Output Amp. Stage Screen Decoupling
C-420	.47 Mfd.	Pyramid	7PG1H	20%	200	B- Power Supply Filter
C-421	.25 Mfd.	Pyramid	7EPGH	20%	300	Negative Supply Decoupling
C-422	20 Mmf.	El-Menco	CM15C-200J	5%	500	Output Amp. Feedback Condenser
C-423	.05 Mfd.	Pyramid	EPG1H	20%	300	Output Amp. Stage Screen Decoupling
C-424	910 Mmf.	El-Menco	CM19B-911K	10%	500	Output Gain Switch Stabilizer
C-425	360 Mmf.	El-Menco	CM19B-361K	10%	500	Output Gain Switch Stabilizer
C-426	200 Mmf.	El-Menco	CM19B-201K	10%	500	Output Gain Switch Stabilizer
C-427	110 Mmf.	El-Menco	CM19B-111K	10%	500	Output Gain Switch Stabilizer
C-428	68 Mmf.	El-Menco	CM19B-680K	10%	500	Output Gain Switch Stabilizer

Symbol	Description	Manufacturer	Type	Function
F-1	Fuse	Littelfuse	313002	Line Fuse
F-2	Fuse	Littelfuse	313500 .5 Amp.	Regulated Line Fuse, 67F Model Only
I-1	Signal Light	Dialco	8-1930-121	On-Off Indicator
I-2	NE2D	Dialco or G.E.		Zero Signal Lamp
J-101	Jack	E.F. Johnson Co.	105-602-1	Input Test
J-401	Jack	E.F. Johnson	105-610-1	Output Test
L-1	12 Hy. Inductor	Colin Campbell Co.	L-1855	B- Ripple Filter
L-1101	See Channel Selector Parts List			
L-1102	See Channel Selector Parts List			
L-1103	See Channel Selector Parts List			
L-1104	See Channel Selector Parts List			
L-401	.001 H	Miller	4632	B- Decoupling Choke
M-101	Panel Meter	Marion Electric	HS-0.2 ma	Input Level Indicator
M-401	Panel Meter	Marion Electric	HS-0.1-0-0.1 ma	Output Level Indicator
P-1	Connector	Cannon Electric	DPD-D32C2-34P-1L	Chassis Connector
P-2	Connector	EMR	B-00040	Operating Channel Plug-in Receptacle
SW-1	DPDT Switch	A.H. & H	81024-F	Power On-Off Switch
SW-401	Attenuator	EMR	-------	Select Output Level and Condition
SW-402	P.B. Switch	Microswitch	2AC1	Output Amplifier Input Shorting
V-1	Full Wave Rectifier	Sylvania	5V4GA	B± Rectifier
V-2	Full Wave Rectifier	Sylvania	5V4GA	B- Rectifier
V-3	Power Amp. Twin Triode	RCA	6080	B± and B- Regulator
V-4	Triode-Pentode	Tung-Sol	6AW8	B± Regulation Amplifier
V-5	Glow Discharge Tube	Raytheon	5651WA	Voltage Reference
V-6	Triode-Pentode	Tung-Sol	6AW8	B- Regulation Amplifier
V-101	Twin-Triode Amp.	RCA	12AT7	1st and 2nd Filter Cathode Follower
V-102	Twin-Triode Amp.	RCA	12AT7	3rd and 4th Filter Cathode Follower
V-103	Twin-Triode Amp.	RCA	12AY7	Filtered Input Signal Amplifier
V-201	R.F. Amp. Pentode	RCA	6AU6	Limiter
V-202	Dual Diode	RCA	6AL5	Limiter Level Setting
V-203	Twin Triode	RCA	5964	Trigger
V-301	R. F. Amp. Pentode	RCA	6AU6	Pulse Generator
V-302	R. F. Amp. Pentode	RCA	6AU6	Discriminator
V-303	Twin Triode	GE	6201	Diode Clipper-Cathode Follower

Symbol	Description	Manufacturer	Type	Function
V-304	R. F. Amp. Pentode	GE	6136	Discriminator
V-305	R. F. Amp. Pentode	RCA	6AU6	Output Clamping
V-401	Twin-Triode	RCA	12AY7	Output Filter Amplifier
V-402	Triode-Pentode	RCA	6U8	Output Filter Amplifier
V-403	Triode-Pentode	Tung-Sol	6AW8A	Output Filter Amplifier
V-404	R. F. Amp. Pentode	RCA	6AU6	Output Filter Amplifier
V-405	Beam Power Amp.	RCA	6197	Output Filter Amplifier
V-406	Beam Power Amp.	GE	6L6GB	Output Filter Cathode Follower
T-1	Power Transformer	Colin Campbell	L-2002	Power Transformer (Used on D Model Only)
T-1	Power Transformer	Colin Campbell	L-1926	Power Transformer (Used on F Model Only)

Description	Manufacturer	Type	Function
1/8" Bakelite Terminal Board	EMR	A-00066	Mounting Small Positive Supply Parts
1/8" Bakelite Terminal Board	EMR	A-00182	Mounting Small Negative Supply Parts
1/8" Bakelite Terminal Board	EMR	B-00046	Mounting Small Output Filter Parts
1/8" Bakelite Terminal Board	EMR	A-00178	Mounting Small Limiter Parts
1/8" Bakelite Terminal Board	EMR	A-00183	Mounting Small Discriminator and Pulse Generator Parts
1/8" Bakelite Terminal Board	EMR	B-00089	Mounting Small Bias Power Supply Parts
1/8" Bakelite Terminal Board	EMR	C-00064	Mounting Small Discriminator and Output Filter Parts
1/8" Bakelite Terminal Board	EMR	C-00062	Mounting Small Input Filter Parts
Octal Sockets	Cinch	16220	
7 Pin Sockets	Cinch	9355	
9 Pin Sockets	Cinch	13381	
7 Pin Tube Shield	Cinch	8690-1	
7 Pin Tube Shields	Cinch	8691-1	
9 Pin Tube Shields	Cinch	12628	
9 Pin Tube Shields	Cinch	13376	
7 Pin Shield	Intern'l Elec. Res. Corp.	TR-6-6025	
Tube Clamps	Birtcher	926-C	
Tube Clamp	Birtcher	926-H-6080	
Guide Pin Bushings	Cannon	AN-3064-8	
Coupling Nut	Cannon	AN-3066-8	
Knobs	Raytheon	70-3-2G, 70-1-1G, 8925301-17791	
Fuse Holders	Littelfuse	342003	
Nylon Cable Clamp	Burndy	HP-5N	
Nylon Cable Clamp	Burndy	HP-7N	
Pilot Bulb	General Electric	328	
Plug in Unit Receptacle Card) See Channel Selector Parts List			
Plug in Unit Receptacle) See Low Pass Filter Insert Parts List			
1/8" Bakelite Terminal Board) See Low Pass Filter Insert Parts List			
1/8" Bakelite Terminal Board) See Low Pass Filter Insert Parts List			

MODEL 67 CHANNEL SELECTOR UNIT REPLACEABLE PARTS

Symbol	Description	Manufacturer	Type and Tolerance		Function
R-1104	*	Electra	DC-1/2c	1%	1st Filter Amplifier Q Setting
R-1106	*	Electra	DC-1/2c	1%	2nd Filter Amplifier Q Setting
R-1108	*	Electra	DC-1/2c	1%	3rd Filter, Amplifier Q Setting
R-1110	*	Electra	DC-1/2c	1%	4th Filter Amplifier Q Setting
R-1314	250 K	Shallcross	P-34-E	1%	Discriminator Grid Return
R-1322	100 K	Helipot	AZ		Discriminator Centering Control
R-1401	100 K/200 K**	Electra	DC-1/2c	1%	Output Filter Element, Series R
R-1443	200 K***	Electra	DC-1/2c	1%	Output Filter Element, Divider
C-1102	*	El-Menco			1st Section Input Filter Tuning
C-1104	*	El-Menco			2nd Section Input Filter Tuning
C-1105	*	El-Menco			3rd Section Input Filter Tuning
C-1106	*	El-Menco			4th Section Input Filter Tuning
C-1306	*	El-Menco			Frequency Determing Capacity
L-1101	*Toroid		*		Input Filter
L-1102	*Toriod		*		Input Filter
L-1103	*Toriod		*		Input Filter
L-1104	*Toriod		*		Input Filter
	Plug in unit receptacle card	EMR	B-00036		(mates with B-00040)

* Factory Adjusted
** 100 K in 7.5% Units/ 200 K in 15% Units.
*** Used on 15% Units Only.

DISCRIMINATOR TUNING CAPACITOR (C-1306) VALUES

Subcarrier Band	Capacity (mmf.)	Type
400	6200	CM-30
560	4300	CM-30
730	3600	CM-30
960	2700	CM-30
1300	2000	CM-30
1700	1500	CM-20
2300	1100	CM-20
3000	820	CM-20
3900	620	CM-20
5400	470	CM-20
7350	330	CM-15
10500	240	CM-15
12300	200	CM-15
14500	160	CM-15
22000	110	CM-15
30000	82	CM-15
40000	62	CM-15
525000	47	CM-15
70000	33	CM-15

All Values Silvered Mica, El Menco, 500 Volt Rating, 5% Tol.